Network pharmacology of medicinal attributes and functions of Chinese herbal medicines: (I) Basic statistics of medicinal attributes and functions for more than 1100 Chinese herbal medicines

WenJun Zhang

School of Life Sciences, Sun Yat-sen University, Guangzhou 510275, China; International Academy of Ecology and Environmental Sciences, Hong Kong

E-mail: zhwj@mail.sysu.edu.cn, wjzhang@iaees.org

Abstract

Based on the Pharmacopoeia of the People's Republic of China, Chinese Materia Medica, and other resources, I collected a total of 1127 Chinese herbal medicines mainly with recorded chemical composition. Of which 210 families and approximately 2000 species of medicinal plants and fungi were involved. According to the comparison, in total of 69 medicinal attributes (Shu Xing) and 78 medicinal functions (Gon Xiao), including 22 medicinal organs or tissues, 7 taste attributes, 5 medicinal properties, 1 toxicity attribute, 22 chemical composition categories, 12 meridians and collaterals (Gui Jing), and 78 medicinal functions were determined. All of the Chinese herbal medicines were numerically coded according to drug name, species, family, 69 medicinal attributes and 78 medicinal functions. Finally, an interactive coding database, CHM-DATA, which contains 8 tables, was obtained. Statistics, e.g., totals, frequencies or probabilities, percentages, etc., were calculated on the basis of total population of medicines and families.

1 Introduction

Chinese tranditional medicines are a traditional Chinese culture and national treasure of China. For thousands of years, Traditional Chinese Medicine has played an important role in ensuring the health and longevity of Chinese people. Theory and practice of Tranditional Chinese Medicine are continuously improved and developed over the past thousands of years. Over the past 20 years, western medicine is facing more and more difficulties in solving human health. This is mainly manifested that in the past 20 years the successful stories of drug design have been significantly decreased. Because of the lack of function and unexpected toxicity of drugs, failure in clinical trials accounts for more than half of drug failure cases around the world. The main reason is due to the biased guiding ideology of drug design based on the single drug-single target-single disease view in traditional western pharmacology (Budovsky and Fraifeld, 2012; Zhang, 2016b). Complex diseases, such as cancer and diabetes, etc., do not usually arise from mutation or dysfunction of a single

molecule, but are usually caused by dysfunction of related whole regulation network (Zhang, 2016a, b). In a network, a single molecule is a network node. So even a single molecule changes insignificantly, they will collectively lead to a substantial change in the whole signal path. At the level of network, cancer-related mutations will mostly appear in the genes of specific signaling pathways. Thus for diagnosis and treatment of cancer and other complex diseases, the target is not surely a single gene, but may be a specific pathway or network. Therefore, network-based disease analysis is imperative (Hopkins, 2007, 2008; Zhang, 2016b). On the other hand, the theory of Chinese traditional medicine focuses on the whole regulation of biological network, so brings a hope to disease prevention and drug research / development. It prompts many people to look back to this ancient and mysterious oriental medical system. During the past 10 years, however, Chinese medicine, especially the theoretical system of Chinese herbal medicine has been considerably questioned, mainly because intrinsic mechanism and scientific principles of Chinese traditional medicines have still not reasonably explained and it lacks of theoretical system of network pharmacology (Zhang, 2016b). The theory always gives people with "metaphysical" impression. As one of the initiatives, in recent years the country has greatly increased the support for the research and application of Chinese traditional medicine, among which the standardization and internationalization of Chinese traditional medicines is one of the important content. Not long ago, the state government asked people to suppress the exaggeration of function of Chinese traditional medicines, including superstition and vulgar language. Therefore, it is necessary to establish a new and reasonable naming and interpretation system for traditional Chinese medicines, which should be based on a deep understanding on scientific and accurate mechanism of medicines.

In China, there are more than 11000 medicinal plants and fungi, accounting for more than 85% of traditional Chinese medicines. In the past, some researchers have used statistical methods to study the four Qi and functions of traditional Chinese medicines, the natural attributes of medicines, etc. Through such basic research, we can correct the deviation of medicinal cognition and further enrich and perfect the theory of medicinal attributes (Wang, 2012). Nevertheless, in spite of the massive literature, so far there is still a lack of extensive and in-depth research and coverage in this topic. As the first step of our series studies, the aim of this study is to obtain the basic statistics of medicinal attributes and functions of Chinese herbal medicines by analyzing the large-scale data sources. This will provide a scientific basis for further application.

2 Materials and Methods

2.1 Data sources

Data for Chinese herbal medicines were collected from Pharmacopoeia People's Republic of China (National Pharmacopoeia Commission, 2015), Chinese Materia Medica (Editorial Board of Chinese Materia Medica, 1999), Compilation of National Herbal Medicines (Editorial Board of Compilation of National Herbal Medicines, 1975; Wang, 2006), Dictionary of Chinese Traditional Medicines (Nanjing University of Chinese Medicine, 2006), Query Platform for Promotion of Norms of Chinese Medicines, Terminology, Achievements, and Medical Information (2017), Chinese Flora (Editorial Board of Chinese Flora, 2004), Medicinal Plants in Southern China (Wang and Cai, 2011), Medicinal Plants in Northern China (Ding, 2009), Network of Chinese Medicine (2017), Compendium of Materia Medica (Li, 2012), Chinese Traditional Medicines (Zhong Yi Shi Jia, 2017), Baidu Encyclopedia (Baidu, 2017), Practical Alias Handbook of Chinese Traditional Medicines (Bao, 1997), etc. Among them, the Pharmacopoeia People's Republic of China, Chinese Materia Medica, and Compilation of National Herbal Medicines are three of the major data sources. Collection was focused on the Chinese herbal medicines with reported chemical composition. A total of 1127 medicines, involving about 2000 species of medicinal plants and fungi were collected, which account for approximately 1/5 of medicinal plants and fungi in China. Among them, medicinal plants accounted for 98.94%, and medicinal fungi

accounted for 1.06%. The list included the most commonly used or important Chinese herbal medicines.

The collection criterion for Chinese herbal medicines is mainly dependent on the authority of data sources. In addition, a variety of literature and records on Chinese herbal medicines are used also. Thus, the data has not only strict statistical characteristics, but also big data characteristics. That is, data analysis has a certain fault tolerance: a small amount of inconsistencies between the sources or records do not affect the results of the trend analysis. Taking into account the differences in the definition of medicinal attributes and functions, the combination of both authoritative and diversified sources is reasonable, which helps to avoid the specificity and limitations of the results, and thus help to avoide systematic deviations of result analysis. Thus, the results are expected to be most reasonable and representative.

2.2 Determination of medicinal attributes and functions

2.2.1 Medicinal organs or tissues

Medicinal organs or tissues recorded in present study are attributed to the following 22 parts, where the whole body represents the complete and full organism: whole body, above-ground part, root, rhizome, stem / stalk, branch / twig, leaf, flower / flower bud / flower inflorescence, flower style, pollen, fruit infructescence / fruit cluster, fruit, seed, seed kernel, seed coat, fruit flesh, fruit peel / fruit shell, stem bark, root bark, stem pith, branch pith / root pith , resin / juice, and fungal fruiting body / fungal sclerotium.

2.2.2 Taste attributes (Wei in Chinese)

A total of 7 taste attributes were used: bitter, symplectic, sweet, light, sour, astringent, and salty.

2.2.3 Medicinal properties (Xing in Chinese)

There are 5 medicinal properties: cold, cool, temperate, warm, and hot.

2.2.4 Toxicity attribute

Toxicity is only expressed as toxic or non-toxic.

2.2.5 Chemical composition categories

In principle, the chemical composition of each medicinal plant or fungus is extremely complex and difficult to enumerate. In present study, an estimated 10000 kinds of potential active ingredients were reported according to the literature. The chemicals were classified into the following categories: glycosides, organic acids, alkaloids, amines, sterols, volatile oils / ordinary oils, proteins / amino acids, terpenoids , phenols , aldehydes, esters / fats, carbohydrates / starch, alcohols, enzymes, ketones / flavonoids, alkanes / hydrocarbons, ethers, olefins, anthracene / quinones, tannins, vitamins, inorganic substances. Chemical substances hydrolyzed from glycosides, etc., are listed also in these categories. Some substances are rarely met and lack of representation, and thus omitted for category classification.

2.2.6 Meridians and collaterals (Gui Jing in Chinese)

According to statistics, a total of 12 categories of meridians and collaterals were used: liver meridians and collaterals, gallbaldder meridians and collaterals, urinary bladder meridians and collaterals, kidney meridians and collaterals, lung meridians and collaterals, spleen meridians and collaterals, stomach meridians and collaterals, heart meridians and collaterals, large intestine meridians and collaterals, small intestine meridians and collaterals, blood phase, and triple burner.

2.2.7 Medicinal functions (Gong Xiao in Chinese)

There are various definitions and terminology on the medicinal functions of Chinese traditional medicines in different literature. In present study they are summarized as the following 78 functions, there inevitably has certain degree of overlapping between some of them (Chinese terminology is listed also for possible comparison):

In short, some of the aforementioned functions overlap partially in their meaning and implication, which will not have a substantial impact on the statistical analysis.

Function	Clean liver，relax liver，consolidate liver，bright eyes or eliminate eye screens	Breed or blacked hair	Benefit gallbladder or cure jaundice	Reduce aminotransferase	Consolidate or warm kidney	Induce diuresis or treat strangurt
功效	清肝/补肝/舒肝/明目/退翳	生发/乌发	利胆/退黄	降转氨酶	补肾/温肾	利尿/通淋
Function	Activate water metabolism or excrete water	Invigorate male impotence (Yang) or strengthen male essence	Strengthen bones and muscles	Promote granulation	Remove lung-heat or nourish lung	Eliminate or relieve phlegm
功效	利水/行水	壮阳/温阳/益精	强筋骨	生肌	清肺/润肺	祛痰/化痰
Function	Anti-asthma	Eliminate or relieve cough	Eliminate or relieve stuffy nose	Eliminate or relieve tuberculosis	Whet the appetite or reinforce stomach	Strengthen and reinforce spleen
功效	平喘/定喘	止咳	通鼻窍	祛肺结核	开胃/益胃	健脾/补脾
Function	Improve digestion	Promote secretion of saliva or body	Relieve sore throat	Resolve food stagnation	Repel foulness	Prevent or arrest vomiting
功效	消食/化食	生津	利咽	消积/消滞	辟秽	止呕
Function	Strengthen heart or clean heart-fire	Relieve restlessness，calm the nerves，alleviate mental depression，or arrest convulsion	Arrest epilepsy	Relieve constipation	Loosen the bowels	Moisten dryness
功效	强心/清心	除烦/安神/解郁/定惊	定痫	通便	润肠	润燥
Function	Astringe intestine	Soften hardness or dissolve masses	Antidiarrheal	Stop diarrheal	Cool blood	Stop bleeding
功效	涩肠	散结/软坚	止痢	止泻	凉血	止血
Function	Tonify blood	Invigorate blood circulation	Absorb clots，eliminate stasis，resolve carbuncle or promote wound healing	Reduce swelling	Antidiabetics	Antiatheroscloresis
功效	养血/补血	活血	化瘀/消痈/敛疮	消肿	降糖	降血脂
Function	Antihypertension	Nourish essential fluid (Yin)	Regulate menstruation or promote blood flow	Prevent miscarriage or abortion	Promote lactation or stimulate milk secretion	Regulate or enhance energy flow (Qi)
功效	降压	滋阴	调经/通淋	安胎	通乳/下乳	理气/养气
Function	Inhibit or break energy flow (Qi)	Anti-aging	Remove obstruction in meridians and collaterals，or relax the muscles and joints	Nourish，warm spleen，stomach or Qi	Relieve pain	Anticancer
功效	下气/破气	抗衰老	通络/活络/舒筋	温中/和中/补中	止痛	抗癌
Function	Clear away heat	Eliminate dampness	Detoxification	Decrease internal heat	Quench ones thirst	Relieve summer-heat
功效	清热	利湿	解毒	降火	止渴	解暑/消暑
Function	Dispel endogenous cold	Dispel endogenous damp	Dispel endogenous wind	Relieve rheumatism or lubricate the joints	Dry dampness	Suppress perspiration
功效	祛寒	祛湿	祛风	祛风湿/利关节	燥湿	止汗
Function	Induce perspiration	Relieve external syndrome	Promote astringent function	Discharge pus，diminish inflammation or anti-infection	Relieve itching	Kill or expel parasites
功效	发汗	解表/发表	收敛	排脓/消炎/抗感染	止痒	杀虫/驱虫
Function	Anti-malaria	Relieve muscular spasm	Expose exthanthema or promote eruption	Dispel evil spirit	Anesthesia	Eliminate impediment
功效	抗疟/截疟	解痉	透疹	逐邪	麻醉	除痹

2.3 Establish the coding database

For the 1127 Chinese herbal medicines, boolean coding was made for medicine name, species, family, the

above 69 medicinal attributes and 78 medicinal functions. Finally, CHM-DATA Version 1.0, an interactive database that includes eight tables, was established.

2.4 Analytical methods

As the basic work of our series research, the present study mainly focuses on such basic statistics as frequency / probability, percentage, total, etc.

3 Results and Analysis

According to the statistics of 1127 Chinese herbal medicines, a total of 210 plant and fungal families are recorded. Among them, there are 93 Chinese herbal medicines (8.25%) in Asteraceae, which holds the absolute first position, followed by Labiatae (55 medicines, 4.88%), Leguminosae (52 medicines, 4.61%), Ranunculaceae (38 medicines, 3.37%), Rosaceae (31 medicines, 2.75%), Liliaceae (28 medicines, 2.48%), Polygonaceae (28 medicines, 2.48%), Apiaceae (27 medicines, 2.4%), Rubiaceae (21 medicines, 1.86%), Euphorbiaceae (21 medicines, 1.86%), Solanaceae (20 medicines, 1.77%), Gramineae (18 medicines, 1.6%), Scrophulariaceae (18 medicines, 1.6%), Rutaceae (18 medicines, 1.6%), Zingiberaceae (17 medicines, 1.51%), Asclepiadaceae (17 medicines,1.51%), Menispermaceae (16 medicines, 1.42%), Lauraceae (15 medicines, 1.33%), Moraceae (15 medicines, 1.33%), Araliaceae (15 medicines, 1.33%), Papaveraceae (15 medicines, 1.33%), etc. (Table 1, Fig. 1). In general, Asteraceae, Labiatae, and Leguminosae, etc., are the major families for Chinese herbal medicines (21 dominant families).

Table 1 Family composition of 1127 Chinese herbal medicines.

Family	Ephedraceae	Lauraceae	Labiatae	Zingiberaceae	Apiaceae	Asteraceae	Moraceae	Leguminosae	Verbenaceae	Ranunculaceae
No. medicines	1	15	55	17	27	93	15	52	12	38
Family	Liliaceae	Cucurbitaceae	Rubiaceae	Gramineae	Gentianaceae	Scrophulariaceae	Boraginaceae	Caprifoliaceae	Oleaceae	Brassicaceae
No. medicines	28	11	21	18	6	18	2	3	9	11
Family	Saururaceae	Iridaceae	Valerianaceae	Acanthaceae	Polygonaceae	Portulacaceae	Violaceae	Crassulaceae	Lycoperdaceae	Solanaceae
No. medicines	1	5	4	5	28	1	2	6	1	20
Family	Asclepiadaceae	Caryophyllaceae	Rosaceae	Euphorbiaceae	Convolvulaceae	Menispermaceae	Loranthaceae	Araliaceae	Apocynaceae	Magnoliaceae
No. medicines	17	12	31	21	8	16	2	15	8	8
Family	Polyporaceae	Alismataceae	Plantaginaceae	Lardizabalaceae	Primulaceae	Chenopodiaceae	Rutaceae	Aristolochiaceae	Myrtaceae	Cyperaceae
No. medicines	4	1	2	3	4	8	18	12	5	7
Family	Thymelaeaceae	Meliaceae	Combretaceae	Arecaceae	Equisetaceae	Araceae	Sterculiaceae	Orchidaceae	Berberidaceae	Bombacaceae
No. medicines	5	5	2	4	4	12	4	11	8	1
Family	Aquifoliaceae	Campanulaceae	Vitaceae	Urticaceae	Simaroubaceae	Myrsinaceae	Dioscoreaceae	Loganiaceae	Phytolaccaceae	Tiliaceae
No. medicines	6	6	4	6	4	3	6	3	1	5
Family	Amaranthaceae	Bignoniaceae	Ginkgoaceae	Stemonaceae	Sargassaceae	Papaveraceae	Celastraceae	Santalaceae	Theaceae	Auriculariaceae
No. medicines	11	4	1	1	1	15	8	2	6	1
Family	Pteridaceae	Cupressaceae	Nymphaeaceae	Hamamelidaceae	Typhaceae	Piperaceae	Alangiaceae	Selaginellaceae	Actinidiaceae	Ericaceae
No. medicines	5	6	4	4	1	3	2	4	2	11
Family	Papilionaceae	Flacourtiaceae	Amaryllidaceae	Guttiferae	Juncaceae	Commelinaceae	Lygodiaceae	Rhamnaceae	Sapindaceae	Orobanchaceae
No. medicines	1	9	6	2	5	1	4	6	3	3
Family	Eucommiaceae	Dicksoniaceae	Juglandaceae	Polypodiaceae	Cuscutaceae	Pedaliaceae	Dipsacaceae	Cynomoriaceae	Styracaceae	Cornaceae
No. medicines	1	1	2	7	1	1	1	1	2	2
Family	Punicaceae	Polygalaceae	Zygophyllaceae	Ulmaceae	Taxaceae	Dryopteridaceae	Tricholomataceae	Burseraceae	Sparganiaceae	Onagraceae
No. medicines	1	1	2	3	2	1	2	3	1	3
Family	Balsaminaceae	Nyssaceae	Saxifragaceae	Actinidiaceae	Musaceae	Blechnaceae	Malvaceae	Aizoaceae	Annonaceae	Schisandraceae
No. medicines	2	1	4	1	1	1	7	1	2	1
Family	Buxaceae	Passifloraceae	Agavaceae	Cyatheaceae	Pyrolaceae	Basellaceae	Trapoideae	Calycanthaceae	Geraniaceae	Capparaceae
No. medicines	1	2	2	1	1	1	1	1	2	2
Family	Casuarinaceae	Gnetaceae	Oxalidaceae	Marsileaceae	Ophioglossaceae	Solieriaceae	Begoniaceae	Lythraceae	Myristicaceae	Cycadaceae
No. medicines	1	1	3	1	1	1	2	4	1	2
Family	Lycopodiaceae	Davalliaceae	Molluginaceae	Gelidiaceae	Anacardiaceae	Corallinaceae	Elaeagnaceae	Fagaceae	Ebenaceae	Usneaceae
No. medicines	5	1	1	1	2	1	3	2	1	1
Family	Pinaceae	Taxodiaceae	Hippocastanaceae	Pteridaceae	Tamaricaceae	Cactaceae	Tremellaceae	Myricaceae	Linaceae	Salicaceae
No. medicines	4	1	1	1	1	1	1	1	2	2
Family	Buddlejaceae	Bangiaceae	Nyctaginaceae	Phallaceae	Marantaceae	Podocarpaceae	Chloranthaceae	Adiantaceae	Nepenthaceae	Betulaceae
No. medicines	2	1	1	1	1	1	1	1	1	1
Family	Dennstaedtiaceae	Huperziaceae	Oscillatoriaceae	Boletaceae	Sphagnaceae	Conocephalaceae	Chordaceae	Cladoniaceae	Umbilicariaceae	Rebouliaceae
No. medicines	2	2	1	1	1	1	1	1	1	1
Family	Athyriaceae	Cephalotaxaceae	Philydraceae	Melastomataceae	Climaciaceae	Scytosiphonaceae	Russulaceae	Frullaniaceae	Lindsaeaceae	Aspleniaceae
No. medicines	1	1	1	1	1	1	1	1	1	3
Family	Gleicheniaceae	Stereocaulaceae	Psilotaceae	Mniaceae	Sinopteridaceae	Illiciaceae	Dilleniaceae	Plumbaginaceae	Osmundaceae	Bartramiaceae
No. medicines	1	1	1	1	2	1	1	1	1	1
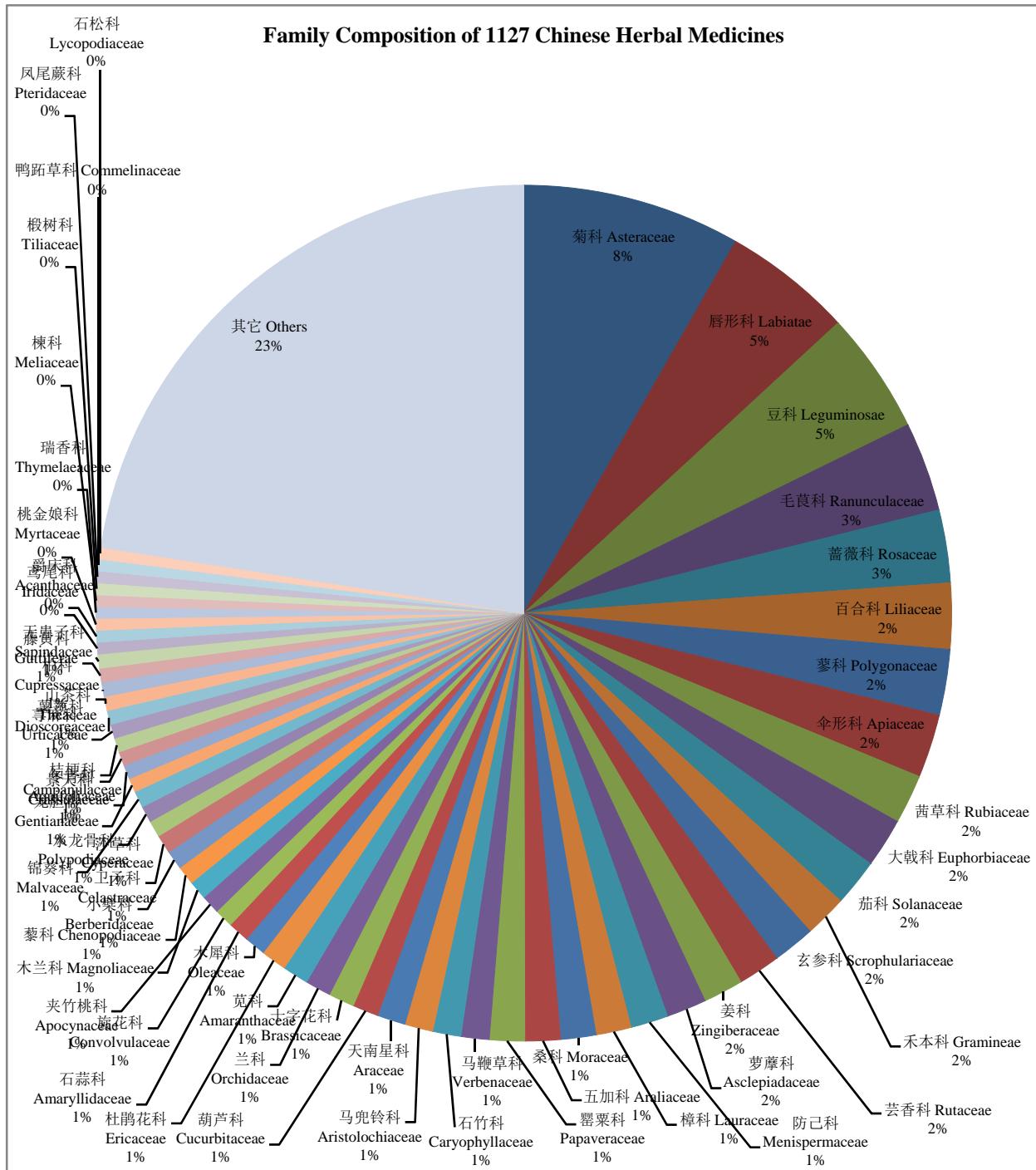
Fig. 1 Family composition of 1127 Chinese herbal medicines.

3.1 Medicinal organs / tissues

Utilization percentage of each organ / tissue over all organs / tissues is whole body (25%), root (19%), leaf (12%), stem / stalk (8%), fruit (7%), rhizome (7%), seed (5%), etc (Table 2, Fig. 2). Whole body used in all herb medicines accounted for 32.83% (370 medicines), and root accounted for 24.4% (275 medicines), followed by leaf (15.26%, 172 medicines), stem / stalk (10.03%, 113 medicines), fruit (9.49%, 107 medicines), rhizome (9.05%, 102 medicines), flower / flower bud / flower inflorescence (6.65%, 75 medicines), seed (6.12%, 69 medicines), etc (Table 2, Fig. 2). In general, Chinese herbal medicines take whole body, root and

leaf as the major medicinal organs / tissues.

In the above 21 dominant families, the families with whole body as the major medicinal organ / tissue include Asteraceae (occurrence frequency or probability: 0.67), Labiatae (0.62), Scrophulariaceae (0.61), Rubiaceae (0.48), Polygonaceae (0.46), Gramineae (0.33), Solanaceae (0.3), Euphorbiaceae (0.24). The families with root as the major medicinal organ / tissue include Menispermaceae (0.75), Ranunculaceae (0.63), Asclepiadaceae (0.59), Apiaceae (0.52), Araliaceae (0.4), Lauraceae (0.33), Solanaceae (0.3), and Papaveraceae (0.27). The families Zingiberaceae (0.53) and Liliaceae (0.46) take rhizome as the major medicinal organ / tissue. The families Moraceae (0.33) and Euphorbiaceae (0.24) take leaf, and Leguminosae (0.19) takes seed as the major medicinal organ / tissue. The families Rutaceae (0.5), Rosaceae (0.42) and Moraceae (0.33) take fruit as the major medicinal organ / tissue. More results are listed in the supplementary material.

Table 2 Utilization frequency of organs/tissues in 1127 Chinese herbal medicines.

Organ/Tissue	Whole body	Above-ground part	Root	Rhizome	Stem or stalk	Branch or twig	Leaf	Flower，flower bud or flower inflorescence	Flower style	Pollen	Fruit infructescence or fruit cluster
药用部位	全株/全草	地上部分	根	根茎	茎	枝	叶	花/花蕾/花序	花柱	花粉	果序/果穗
Total	370	32	275	102	113	36	172	75	1	3	2
Frequency	0.3283	0.0284	0.244	0.0905	0.1003	0.0319	0.1526	0.0665	0.0009	0.0027	0.0018
Organ/Tissue	Fruit	Seed	Seed kernel	Seed coat	Fruit flesh	Fruit peel or fruit shell	Stem bark	Root bark	Stem pith，branch pith or root pith	Resin / Juice	Fungal fruiting body or fungal sclerotium
药用部位	果实	种子	种仁	种皮	果肉	果皮/果壳	茎皮	根皮	茎髓/枝髓/根髓	汁液/树脂	子实体/菌核
Total	107	69	2	1	2	9	33	24	5	14	12
Frequency	0.0949	0.0612	0.0018	0.0009	0.0018	0.008	0.0293	0.0213	0.0044	0.0124	0.0106

3.2 Taste attributes

The taste attribute with the maximum occurrence percentage over all taste attributes is bitter (38.37%), followed by symplectic (26.16%), sweet (21.74%), astringent (4.65%), sour (4.48%), light (3.41%), and salinity (1.19%), respectively (Table 3, Fig. 3). Occurrence frequency (probability) of each taste attribute in 1127 Chinese herbal medicines is 0.6096 (676 medicines) for bitter, followed by 0.4157 (461 medicines) for symplectic, 0.3454 (383 medicines) for sweet, 0.0739% (82 medicines) for astringent, 0.0712 (79 medicines) for sour, 0.0541 (60 medicines) for light, and 0.0189 (21 medicines) for salty (Table 3, Fig. 3). In general, Chinese herbal medicines mainly possess bitter, symplectic and sweet attributes.

In the above 21 dominant families, those with bitter and symplectic as the major taste attributes include Asteraceae, Labiatae, Ranunculaceae, Polygonaceae, Apiaceae, Euphorbiaceae, Solanaceae, Rutaceae, and Asclepiadaceae. The families with bitter and sweet as the major taste attributes include, Leguminosae, Liliaceae, Moraceae, and Araliaceae. Papaveraceae, Gramineae and Zingiberaceae take bitter, sweet and symplectic as the major taste attribute, respectively. Rubiaceae takes bitter, symplectic and sweet as its major taste attributes. More results are listed in the supplementary material.
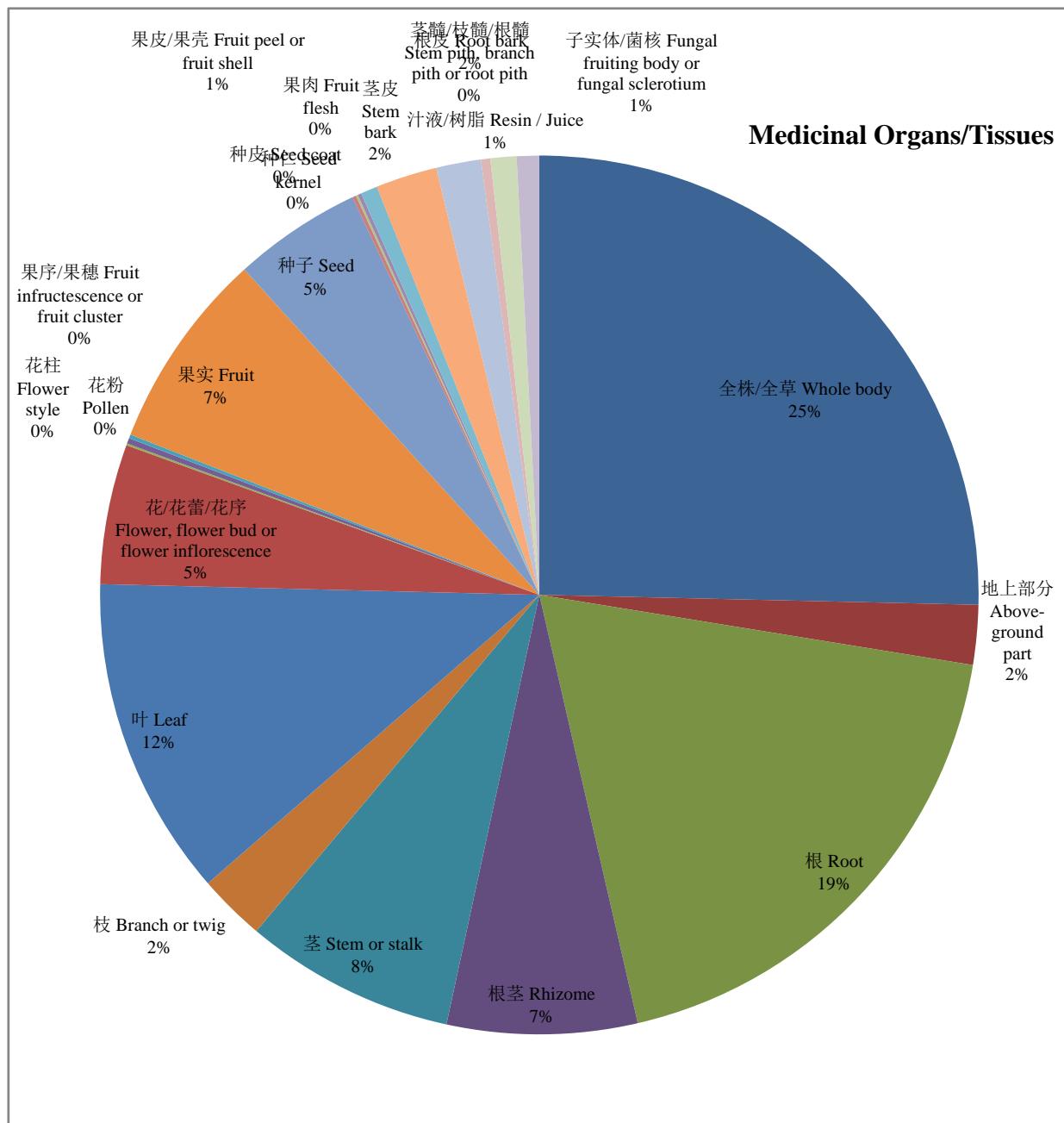
Fig. 2 Utilization percentages of different organs/tissues.

Table 3 Occurrence frequency of taste attributes in 1127 Chinese herbal medicines.

Taste	Bitter	Symplectic	Sweet	Light	Sour	Astringent	Salty
味	苦	辛	甘	淡	酸	涩	咸
Total	676	461	383	60	79	82	21
Frequency	0.6096	0.4157	0.3454	0.0541	0.0712	0.0739	0.0189

Note: Missing data are not calculated.
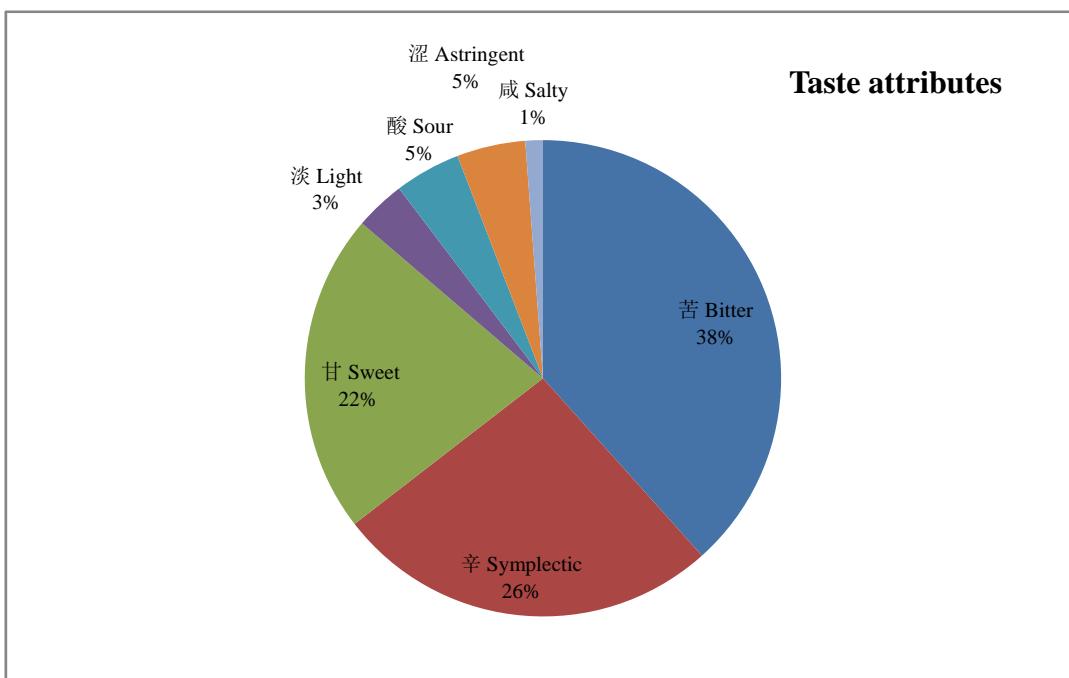
Fig. 3 Percentage of each taste attribute over all taste attributes.

3.3 Medicinal properties

The medicinal properties with the maximum occurrence percentage over all medicinal properties is cold (29.65%), followed by warm (26.15%), temperate (23.18%), cool (19.5%), and hot (1.53%) (Table 4, Fig. 4). Occurrence frequency (probability) of each medicinal property in 1127 Chinese herbal medicines is 0.2976 (330 medicines) for cold, followed by 0.2654 (291 medicines) for warm, 0.2326 (258 medicines) for temperate, 0.1957 (217 medicines) for cool, and 0.0153 (17 medicines) for hot (Table 4, Fig. 4). Generally, Chinese herbal medicines mainly possess cold, warm, temperate and cool properties.

The dominant 21 families with a major medicinal property are Asteraceae (cold), Labiatae (warm), Leguminosae (temperate), Ranunculaceae (cold), Rosaceae (temperate), Liliaceae (cold), Polygonaceae (cold), Apiaceae (warm), Rubiaceae (cold), Euphorbiaceae (cold), Solanaceae (cold), Gramineae (temperate), Scrophulariaceae (cool), Rutaceae (warm), Zingiberaceae (warm), Asclepiadaceae (warm), Menispermaceae (cold), Lauraceae (warm), Moraceae (cold), Araliaceae (warm), and Papaveraceae (cold). More results are listed in the supplementary material.

Table 4 Occurrence frequency of medicinal properties and toxicity in 1127 Chinese herbal medicines.

Property	Cold	Cool	Temperate	Warm	Hot	Toxic
性	寒	凉	平	温	热	毒
Total	330	217	258	291	17	179
Frequency	0.2976	0.1957	0.2326	0.2624	0.0153	0.1614

Note: Missing data are not calculated.
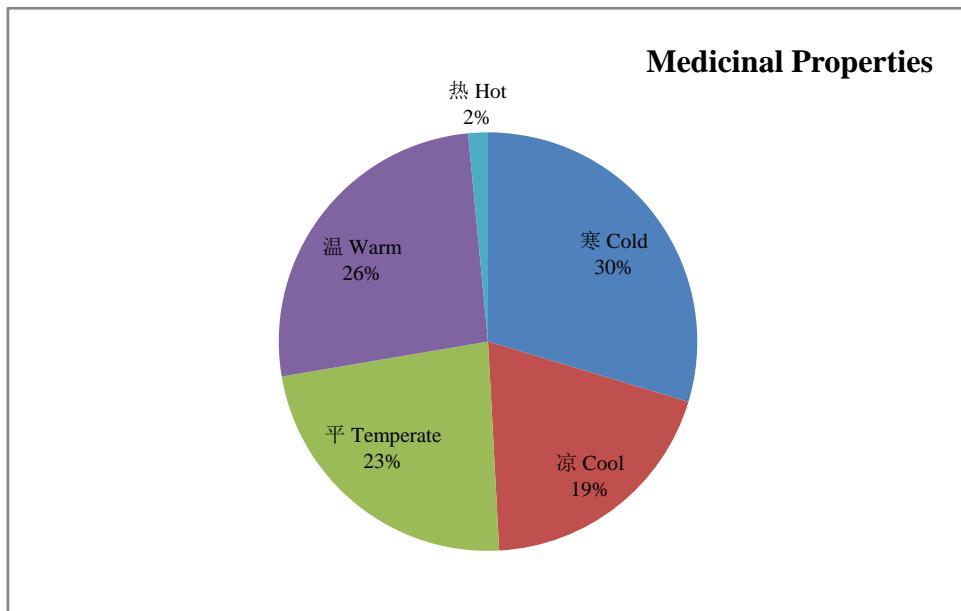
Fig. 4 Percentages of different medicinal properties.

3.4 Toxicity attribute

There are 179 poisonous Chinese herbal medicines (Table 4), accounting for 16.14% of the recorded Chinese herbal medicines (missing data are excluded).

The dominant 21 families with occurrence frequency (probability) from greater to smaller are, Solanaceae (0.65), Euphorbiaceae (0.57), Ranunculaceae (0.42), Papaveraceae (0.4), Rutaceae (0.33), Liliaceae (0.29), Asclepiadaceae (0.29), Leguminosae (0.19), Menispermaceae (0.19), Scrophulariaceae (0.11), Asteraceae (0.08), Apiaceae (0.07), Polygonaceae (0.07), Lauraceae (0.07), Moraceae (0.07), Rubiaceae (0.05), Labiatae (0.04), and Rosaceae (0.03); Gramineae (0), Zingiberaceae (0), and Araliaceae (0) have not recorded toxicity. More results are listed in the supplementary material.

3.5 Chemical composition categories

The chemical composition category with the maximum occurrence percentage over all composition categories is glycosides (14.99%), followed by organic acids (10.9%), alcohols (8.2%), esters / fats (8.18%), ketones / flavonoids (7.78%), alkaloids (6.81%), carbohydrates / starch (6.6%), sterols (6.5%), volatile oils / ordinary oils (5.48%), olefins (4.45%), phenols (4.22%), aldehydes (2.15%), ethers (1.94%), etc (Table 5, Fig. 5).

Glycosides (occurrence frequency or probability 0.5301; 572 medicines) is the most frequent occurred category in 1127 Chinese herbal medicines, followed by organic acids (0.3855, 416 medicines), alcohols (0.2901, 313 medicines), esters / fats (0.2892, 312 medicines), ketones / flavonoids (0.2753, 297 medicines), alkaloids (0.241, 260 medicines), carbohydrates / starch (0.2335, 252 medicines), sterols (0.2298, 248 medicines), volatile oils / ordinary oils (0.1937, 209 medicines), olefins (0.1576, 170 medicines), phenols (0.1492, 161 medicines), aldehydes (0.0076, 82 medicines), and ethers (0.00686, 74 medicines), etc (Table 5, Fig. 5). Overall, active ingredients of Chinese herbal medicines mainly include glycosides, organic acids, alcohols, esters / fats, ketones / flavonoids, and alkaloids, etc.

Occurrency frequencies (probabilities) of the major chemical composition categories of the 21 dominant families are shown in Table 6. For example, both Papaveraceae and Menispermaceae mainly contain alkaloids. Lauraceae mainly contain volatile oils / ordinary oils. Zingiberaceae mainly contain volatile oils / ordinary oils and alcohols. In addition to glycosides, Asteraceae and Labiatae mainly contain organic acids, volatile oils /

ordinary oils, and ketones / flavonoids; Ranunculaceae mainly contains alkaloids; Rosaceae mainly contains organic acids, and ketones / flavonoids; Liliaceae, Gramineae and Araliaceae mainly contain organic acids; Moraceae mainly contain ketones / flavonoids, and Euphorbiaceae mainly contains organic acids and alcohols. More results are listed in the supplementary material.

Table 5 Occurrence frequency of chemical composition categories in 1127 Chinese herbal medicines.

Chemical composition Categories 成份	Glycosides 甙类	Organic acids 有机酸类	Alkaloids 生物碱类	Amines 胺类	Sterols 甾醇类	Volatile oils or ordinary oils 挥发油类/油类	Proteins or amino acids 蛋白质/氨基酸类	Terpenoids 萜类	Phenols 酚类	Aldehydes 醛类	Esters or fats 酯类/脂肪
Total	572	416	260	19	248	209	72	66	161	82	312
Frequency	0.5301	0.3855	0.241	0.0176	0.2298	0.1937	0.0667	0.0612	0.1492	0.076	0.2892
Chemical composition Categories 成份	Carbohydrates or starch 糖类/淀粉	Alcohols 醇类	Enzymes 酶类	Ketones or flavonoids (黄)酮类	Alkanes or hydrocarbons 烷类/烃类	Ethers 醚类	Olefins 烯类	Anthracene or quinones 蒽类/醌类	Tannins 鞣质类	Vitamins 维生素类	Inorganic substances 无机物
Total	252	313	23	297	32	74	170	31	63	72	72
Frequency	0.2335	0.2901	0.0213	0.2753	0.0297	0.0686	0.1576	0.0287	0.0584	0.0667	0.0667

Note: Missing data are not calculated.

Table 6 Occurrence frequency of chemical composition categories in 21 dominant families.

Family	科	Glycosides 甙类	Organic acids 有机酸类	Alkaloids 生物碱类	Sterols 甾醇类	Volatile oils or ordinary oils 挥发油类/油类	Phenols 酚类	Esters or fats 酯类/脂肪	Carbohydrates or starch 糖类/淀粉	Alcohols 醇类	Ketones or flavonoids (黄)酮类	Olefins 烯类
Asteraceae	菊科	0.5269	0.3978	0.2043	0.0108	0.1828	0.3763	0.0323	0.0215	0.129	0.0645	0.4301
Labiatae	唇形科	0.5385	0.4808	0.0769	0	0.2692	0.3462	0.0192	0.0769	0.2115	0.1154	0.25
Leguminosae	豆科	0.6122	0.3469	0.2857	0.0816	0.2449	0.1224	0.1429	0.0408	0.1429	0.0204	0.2245
Ranunculaceae	毛茛科	0.3784	0.2703	0.6486	0.027	0.1892	0	0	0.0541	0.0811	0	0.1622
Rosaceae	蔷薇科	0.5	0.7667	0.0667	0	0.2333	0.1333	0.1	0	0.1	0.1	0.2667
Liliaceae	百合科	0.8214	0.4286	0.2143	0.0357	0.3214	0.0357	0.1429	0	0.1071	0.0357	0.1786
Polygonaceae	蓼科	0.6923	0.5385	0	0	0.3077	0.0769	0.0769	0	0.4231	0.0769	0.1923
Apiaceae	伞形科	0.5926	0.4815	0.037	0	0.2593	0.4815	0.037	0.037	0.3333	0.1852	0.7407
Rubiaceae	茜草科	0.5	0.3	0.35	0	0.4	0.15	0	0.2	0.05	0.05	0.25
Euphorbiaceae	大戟科	0.4737	0.6842	0.1579	0	0.2632	0.2632	0.1053	0.1579	0.1053	0	0.3684
Solanaceae	茄科	0.45	0.3	0.9	0.15	0.25	0	0.05	0.05	0.05	0.1	0.25
Gramineae	禾本科	0.5882	0.4118	0.2941	0	0.2353	0.2353	0.1765	0.0588	0.1176	0.2941	0.2941
Scrophulariaceae	玄参科	0.7059	0.2353	0.0588	0	0.0588	0.1176	0.0588	0.3529	0	0	0.1176
Rutaceae	芸香科	0.5	0.2778	0.5556	0	0.1111	0.5556	0	0	0.0556	0.3333	0.4444
Zingiberaceae	姜科	0.2353	0.1176	0	0	0	0.5882	0	0	0.1765	0.1765	0.4118
Asclepiadaceae	萝藦科	0.8125	0.1875	0.1875	0.0625	0.25	0.0625	0	0.1875	0.125	0.125	0.25
Menispermaceae	防己科	0.0625	0	0.9375	0.0625	0.0625	0	0	0	0	0	0.0625
Lauraceae	樟科	0.2	0.4	0.2	0	0	0.7333	0	0.0667	0.3333	0.4667	0.4667
Moraceae	桑科	0.5333	0.3333	0.2	0	0.2667	0.2	0	0.0667	0.2	0	0.6
Araliaceae	五加科	0.8	0.4667	0	0	0.2	0.1333	0	0	0	0	0.0667
Papaveraceae	罂粟科	0	0	1	0	0	0	0	0	0	0	0
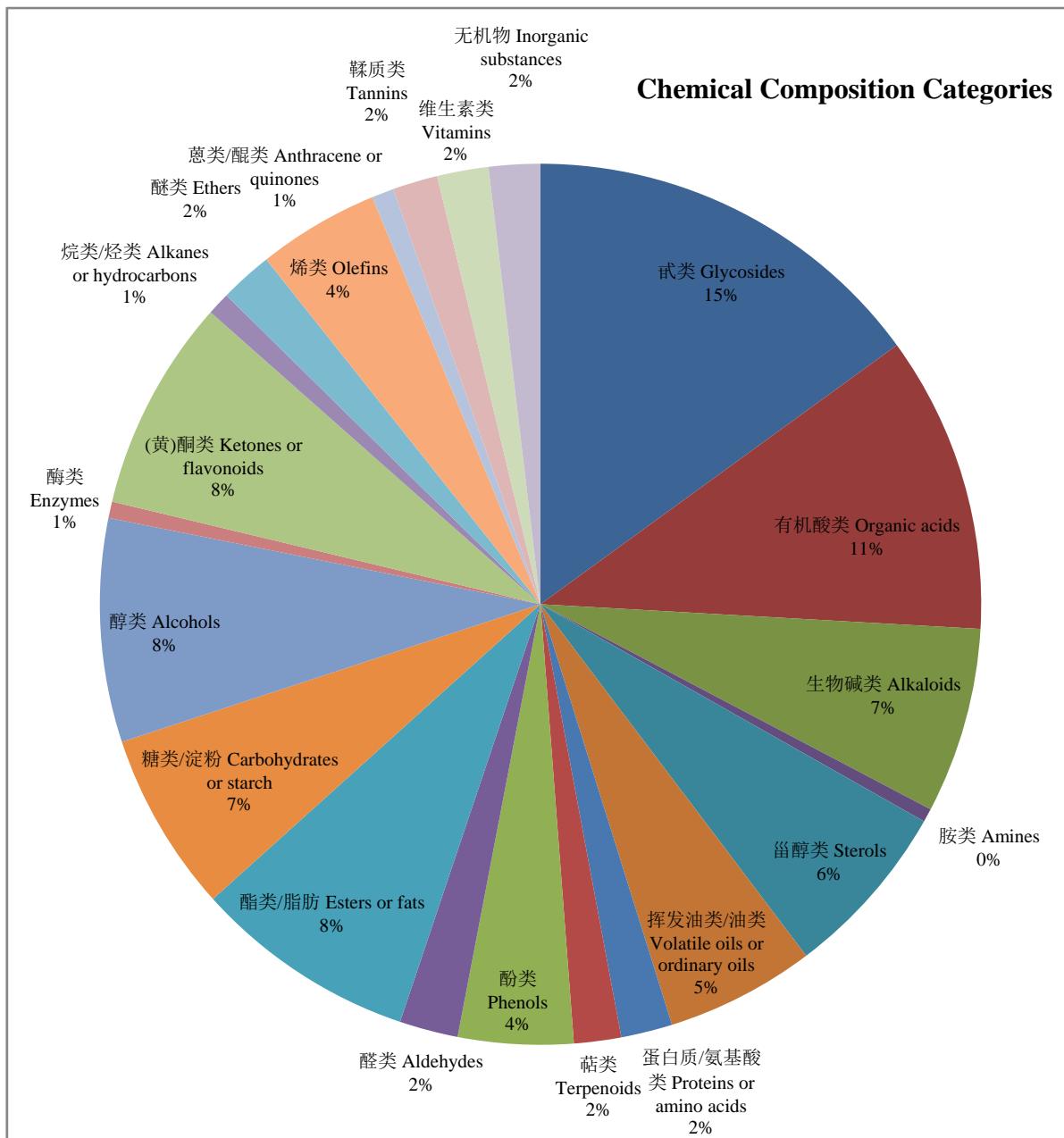
Fig. 5 Percentages of different chemical composition categories.

3.6 Meridians and collaterals

In all of the meridians and collaterals, liver meridians and collaterals account for 23.2%, followed by lung meridians and collaterals (18.9%), stomach meridians and collaterals (13.38%), spleen meridians and collaterals (12.37%), kidney meridians and collaterals (10.19%), heart meridians and collaterals (9.02%), large intestine meridians and collaterals (7.48%), urinary bladder meridians and collaterals (3.45%), small intestine meridians and collaterals (1.43%), gallbladder meridians and collaterals (0.37%), triple burner (0.16%), and blood phase (0.05%) (Table 7, Fig. 6).

The meridians and collaterals with maximum occurrency frequency (probability) in 1127 medicines is liver meridians and collaterals (0.5369, 437 medicines), followed by lung meridians and collaterals (0.4373, 356 medicines), stomach meridians and collaterals (0.3096, 252 medicines), spleen meridians and collaterals

(0.2862, 233 medicines), kidney meridians and collaterals (0.2359, 192 medicines), heart meridians and collaterals (0.2088, 170 medicines), large intestine meridians and collaterals (0.1732, 141 medicines), urinary bladder meridians and collaterals (0.0799, 75 medicines), small intestine meridians and collaterals (0.0332, 27 medicines), gallbladder meridians and collaterals (0.0086, 7 medicines), triple burner (0.0037, 3 medicines), and blood phase (0.0012, 1 medicine) (Table 7, Fig. 6). Overall, liver, lung, stomach and spleen meridians and collaterals are the most important four meridians and collaterals for Chinese herbal medicines.

In the above 21 dominant families, Asteraceae, Labiatae, Solanaceae, Menispermaceae and Papaveraceae act mainly on liver and lung meridians and collaterals. Leguminosae, Rubiaceae, Euphorbiaceae and Ranunculaceae mainly act on liver meridians and collaterals. Zingiberaceae mainly acts on spleen and stomach meridians and collaterals. Lauraceae mainly acts on spleen meridians and collaterals. Gramineae mainly acts on stomach meridians and collaterals, and Araliaceae mainly acts on lung meridians and collaterals (Table 8). More results are listed in the supplementary material.

Table 7 Occurrence frequency of meridians and collaterials in 1127 Chinese herbal medicines.

Meridians & Collaterials	Liver meridians and collaterals	Gallbaldder meridians and collaterals	Urinary bladder meridians and collaterals	Kidney meridians and collaterals	Lung meridians and collaterals	Spleen meridians and collaterals
归经	肝	胆	膀胱	肾	肺	脾
Total	437	7	65	192	356	233
Frequency	0.5369	0.0086	0.0799	0.2359	0.4373	0.2862
Meridians & Collaterials	Stomach meridians and collaterals	Heart meridians and collaterals	Large intestine meridians and collaterals	Small intestine meridians and collaterals	Blood phase	Triple burner
归经	胃	心	大肠	小肠	血分	三焦
Total	252	170	141	27	1	3
Frequency	0.3096	0.2088	0.1732	0.0332	0.0012	0.0037

Note: Missing data are not calculated.

Table 8 Occurrence frequency of meridians and collaterials in 21 dominant families.

Family	科	Liver meridians and collaterals	Gallbaldder meridians and collaterals	Urinary bladder meridians and collaterals	Kidney meridians and collaterals	Lung meridians and collaterals	Spleen meridians and collaterals	Stomach meridians and collaterals	Heart meridians and collaterals	Large intestine meridians and collaterals	Small intestine meridians and collaterals	Blood phase	Triple burner
		肝	胆	膀胱	肾	肺	脾	胃	心	大肠	小肠	血分	三焦
Asteraceae	菊科	0.5676	0.027	0	0.1351	0.5135	0.3243	0.4054	0.0811	0.1622	0	0	0.027
Labiatae	唇形科	0.5161	0.0323	0.0645	0.129	0.6129	0.2581	0.2258	0.1613	0.0968	0.0323	0	0
Leguminosae	豆科	0.5208	0	0.0208	0.2292	0.3125	0.3333	0.2917	0.2917	0.1458	0.0208	0	0
Ranunculaceae	毛茛科	0.6	0	0.0333	0.1333	0.4	0.3667	0.3667	0.3333	0.2667	0	0	0
Rosaceae	蔷薇科	0.68	0	0.12	0.2	0.28	0.56	0.28	0.04	0.36	0.04	0	0
Liliaceae	百合科	0.4286	0	0	0.2857	0.7143	0.0952	0.4762	0.2381	0.1429	0	0	0
Polygonaceae	蓼科	0.4706	0	0.1176	0.0588	0.2941	0.2353	0.4706	0.2353	0.5294	0.0588	0	0
Apiaceae	伞形科	0.4444	0.0556	0.2778	0.2778	0.3333	0.3333	0.2778	0.1111	0.1111	0	0	0
Rubiaceae	茜草科	0.6471	0	0.0588	0.2941	0.2941	0.2353	0.1176	0.2941	0.1765	0.0588	0	0.0588
Euphorbiaceae	大戟科	0.3684	0.0526	0.1579	0.2105	0.3158	0.3158	0.2105	0.2632	0.3158	0.0526	0	0
Solanaceae	茄科	0.6	0	0.1	0.3	0.6	0.1	0.4	0.3	0	0	0	0
Gramineae	禾本科	0.3333	0	0.1667	0.0833	0.4167	0.25	0.5833	0.1667	0.0833	0	0	0
Scrophulariaceae	玄参科	0.6429	0	0	0.5	0.3571	0.1429	0.2143	0.2143	0.0714	0	0	0
Rutaceae	芸香科	0.5294	0	0.1176	0.1765	0.3529	0.4118	0.5882	0	0.1176	0	0	0
Zingiberaceae	姜科	0.3125	0	0	0.1875	0.4375	0.75	0.75	0.125	0.0625	0	0	0
Asclepiadaceae	萝藦科	0.5333	0.0667	0	0.3333	0.3333	0.2667	0.4	0.2	0	0	0	0
Menispermaceae	防己科	0.6154	0	0.2308	0.2308	0.5385	0.4615	0.1538	0.2308	0.3077	0	0	0
Lauraceae	樟科	0.4167	0	0.25	0.3333	0.5833	0.6667	0.4167	0.1667	0	0	0	0
Moraceae	桑科	0.5	0	0.0833	0.25	0.5	0.3333	0.1667	0.0833	0.3333	0	0	0
Araliaceae	五加科	0.4286	0	0	0.4286	0.5714	0.2857	0.4286	0.4286	0	0	0	0
Papaveraceae	罂粟科	0.7273	0	0.1818	0.0909	0.5455	0.0909	0.1818	0.2727	0.1818	0	0	0
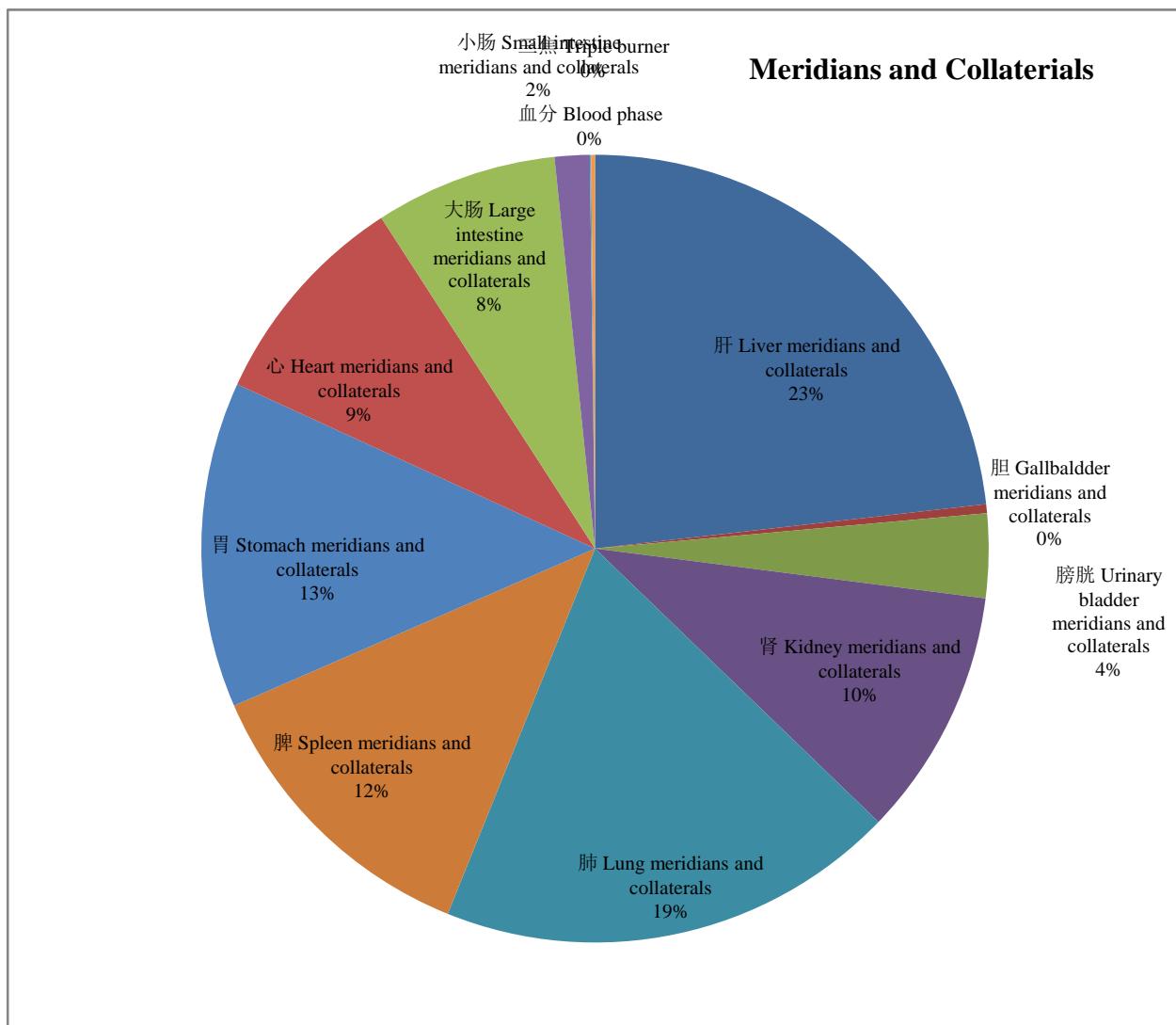
Fig. 6 Percentages of different meridians & collaterals.

3.7 Medicinal functions

Among all of the medicinal functions, the function, clear away heat, is mostly used (9.51%), followed by detoxification (9.34%), relieve pain (5.43%), reduce swelling (4.92%), dispel endogenous wind (4.7%), invigorate blood circulation (4.02%), absorb clots / eliminate stasis / resolve carbuncle / promote wound healing (3.57%), dispel endogenous damp (3.23%), stop bleeding (3.16%), eliminate or relieve cough (2.59%), eliminate dampness (2.54%), Eliminate or relieve phlegm (2.52%), regulate or enhance energy flow (Qi) (2.42%), induce diuresis or treat strangurt (2.27%), clean liver / relax liver / consolidate liver / bright eyes / eliminate eye screens (2.18%), etc (Table 9, Fig. 7).

Among all Chinese herbal medicines, in total of 445 medicines have the function, clear away heat, with the occurrence frequency (probability) of 0.3949, followed by detoxification (437 medicines, 0.3878), relieve pain (254 medicines, 0.2254), reduce swelling (230 medicines, 0.2041), dispel endogenous wind (220 medicines, 0.1952), invigorate blood circulation (188 medicines, 0.1668), absorb clots / eliminate stasis / resolve carbuncle / promote wound healing (167 medicines, 0.1482), dispel endogenous damp (151 medicines, 0.134),

stop bleeding (148 medicines, 0.1313), eliminate or relieve cough (121 medicines, 0.1074), eliminate dampness (119 medicines, 0.1056), Eliminate or relieve phlegm (118 medicines, 0.1047), regulate or enhance energy flow (Qi) (113 medicines, 0.1003), induce diuresis or treat strangurt (106 medicines, 0.0941), clean liver / relax liver / consolidate liver / bright eyes / eliminate eye screens (102 medicines, 0.0905), etc (Table 9, Fig. 7). In general, Chinese herbal medicines mainly function as clear away heat, detoxification, and relieve pain, etc.

In the above 21 dominant families, Asteraceae, Labiatae, Leguminosae, Ranunculaceae, Rosaceae, Liliaceae, Polygonaceae, Rubiaceae, Euphorbiaceae, Solanaceae, Scrophulariaceae, Moraceae, Asclepiadaceae, and Papaveraceae, etc., mainly possess such medicinal functions as clear away heat and detoxification. Zingiberaceae mainly functions as dispel endogenous cold, nourish or warm spleen / stomach / Qi, regulate or enhance energy flow (Qi), and whet the appetite or reinforce stomach. Apiaceae and Asteraceae also function as dispel endogenous wind. The occurrence frequency of clear away heat, detoxification and relieve pain functions in medicines of Menispermaceae is the highest (Table 10). More results are listed in the supplementary material.

Table 9 Occurrence frequency of medicinal functions in 1127 Chinese herbal medicines.

Function	Clean liver, relax liver, consolidate liver, bright eyes or eliminate eye screens	Breed or blacked hair	Benefit gallbladder or cure jaundice	Reduce aminotransferase	Consolidate or warm kidney	Induce diuresis or treat strangurt
功效	清肝/补肝/舒肝/明目/退翳	生发/乌发	利胆/退黄	降转氨酶	补肾/温肾	利尿/通淋
Total	102	2	8	1	61	106
Frequency	0.0905	0.0018	0.0071	0.0009	0.0541	0.0941
Function	Activate water metabolism or excrete water	Invigorate male impotence (Yang) or strengthen male essence	Strengthen bones and muscles	Promote granulation	Remove lung-heat or nourish lung	Eliminate or relieve phlegm
功效	利水/行水	壮阳/温阳/益精	强筋骨	生肌	清肺/润肺	祛痰/化痰
Total	60	45	35	16	71	118
Frequency	0.0532	0.0399	0.0311	0.0142	0.063	0.1047
Function	Anti-asthma	Eliminate or relieve cough	Eliminate or relieve stuffy nose	Eliminate or relieve tuberculosis	Whet the appetite or reinforce stomach	Strengthen and reinforce spleen
功效	平喘/定喘	止咳	通鼻窍	祛肺结核	开胃/益胃	健脾/补脾
Total	40	121	3	2	70	51
Frequency	0.0355	0.1074	0.0027	0.0018	0.0621	0.0453
Function	Improve digestion	Promote secretion of saliva or body	Relieve sore throat	Resolve food stagnation	Repel foulness	Prevent or arrest vomiting
功效	消食/化食	生津	利咽	消积/消滞	辟秽	止呕
Total	41	37	17	40	7	12
Frequency	0.0364	0.0328	0.0151	0.0355	0.0062	0.0106
Function	Strengthen heart or clean heart-fire	Relieve restlessness, calm the nerves, alleviate mental depression, or arrest convulsion	Arrest epilepsy	Relieve constipation	Loosen the bowels	Moisten dryness
功效	强心/清心	除烦/安神/解郁/定惊	定痫	通便	润肠	润燥
Total	24	63	1	35	25	10

Frequency	0.0213	0.0559	0.0009	0.0311	0.0222	0.0089
Function	Astringe intestine	Soften hardness or dissolve masses	Antidiarrheal	Stop diarrheal	Cool blood	Stop bleeding
功效	涩肠	散结/软坚	止痢	止泻	凉血	止血
Total	8	37	15	29	97	148
Frequency	0.0071	0.0328	0.0133	0.0257	0.0861	0.1313
Function	Tonify blood	Invigorate blood circulation	Absorb clots，eliminate stasis，resolve carbuncle or promote wound healing	Reduce swelling	Antidiabetics	Antiatheroscloresis
功效	养血/补血	活血	化瘀/消痈/敛疮	消肿	降糖	降血脂
Total	20	188	167	230	2	3
Frequency	0.0177	0.1668	0.1482	0.2041	0.0018	0.0027
Function	Antihypertension	Nourish essential fluid (Yin)	Regulate menstruation or promote blood flow	Prevent miscarriage or abortion	Promote lactation or stimulate milk secretion	Regulate or enhance energy flow (Qi)
功效	降压	滋阴	调经/通淋	安胎	通乳/下乳	理气/养气
Total	11	23	81	8	13	113
Frequency	0.0098	0.0204	0.0719	0.0071	0.0115	0.1003
Function	Inhibit or break energy flow (Qi)	Anti-aging	Remove obstruction in meridians and collaterals，or relax the muscles and joints	Nourish，warm spleen，stomach or Qi	Relieve pain	Anticancer
功效	下气/破气	抗衰老	通络/活络/舒筋	温中/和中/补中	止痛	抗癌
Total	25	1	68	46	254	12
Frequency	0.0222	0.0009	0.0603	0.0408	0.2254	0.0106
Function	Clear away heat	Eliminate dampness	Detoxification	Decrease internal heat	Quench ones thirst	Relieve summer-heat
功效	清热	利湿	解毒	降火	止渴	解暑/消暑
Total	445	119	437	32	12	19
Frequency	0.3949	0.1056	0.3878	0.0284	0.0106	0.0169
Function	Dispel endogenous cold	Dispel endogenous damp	Dispel endogenous wind	Relieve rheumatism or lubricate the joints	Dry dampness	Suppress perspiration
功效	祛寒	祛湿	祛风	祛风湿/利关节	燥湿	止汗
Total	56	151	220	46	37	3
Frequency	0.0497	0.134	0.1952	0.0408	0.0328	0.0027
Function	Induce perspiration	Relieve external syndrome	Promote astringent function	Discharge pus，diminish inflammation or anti-infection	Relieve itching	Kill or expel parasites
功效	发汗	解表/发表	收敛	排脓/消炎/抗感染	止痒	杀虫/驱虫
Total	9	38	15	50	31	90
Frequency	0.008	0.0337	0.0133	0.0444	0.0275	0.0799
Function	Anti-malaria	Relieve muscular spasm	Expose exthanthema or promote eruption	Dispel evil spirit	Anesthesia	Eliminate impediment
功效	抗疟/截疟	解痉	透疹	逐邪	麻醉	除痹
Total	14	6	18	1	1	4
Frequency	0.0124	0.0053	0.016	0.0009	0.0009	0.0035

Table 10 Occurrence frequency of medicinal functions in 21 dominant families.

Functions	Asteraceae	Labiatae	Leguminosae	Ranunculaceae	Rosaceae	Liliaceae	Polygonaceae	Apiaceae	Rubiaceae	Euphorbiaceae	Solanaceae
	菊科	唇形科	豆科	毛茛科	蔷薇科	百合科	蓼科	伞形科	茜草科	大戟科	茄科
Detoxification	0.4301	0.4182	0.3077	0.5789	0.2258	0.3214	0.6071	0.1852	0.381	0.619	0.45
Relieve pain	0.1613	0.2364	0.1923	0.3421	0.0968	0.2143	0.0357	0.4815	0.2381	0.0476	0.3
Clear away heat	0.5484	0.4545	0.3654	0.6053	0.2581	0.3214	0.5	0.2593	0.5238	0.2857	0.35
Invigorate blood circulation	0.1183	0.2727	0.1346	0.0789	0.1935	0.1071	0.1786	0.1481	0.2381	0.2381	0.1
Dispel endogenous wind	0.2151	0.2182	0.1731	0.2368	0.0645	0.0714	0.1429	0.4074	0.2857	0.2857	0.1
Regulate or enhance energy flow (Qi)	0.0538	0.0909	0.1154	0	0.0968	0.1071	0	0.1852	0	0.0476	0.05
Reduce swelling	0.1613	0.3455	0.0769	0.1579	0.1613	0.1786	0.1786	0.1111	0.3333	0.3333	0.35
Whet the appetite or reinforce stomach	0.0323	0.0364	0.0577	0	0.2258	0.0714	0	0.1111	0.1429	0	0.05
Nourish, warm spleen, stomach or Qi	0.0108	0.0727	0.0577	0	0.0645	0	0	0.0741	0	0	0
Dispel endogenous cold	0.043	0.0364	0.0192	0.1316	0	0	0	0.1852	0	0	0

Functions	Gramineae	Scrophulariaceae	Rutaceae	Zingiberaceae	Asclepiadaceae	Menispermaceae	Lauraceae	Moraceae	Araliaceae	Papaveraceae
	禾本科	玄参科	芸香科	姜科	萝藦科	防己科	樟科	桑科	五加科	罂粟科
Detoxification	0.1667	0.5	0.1667	0	0.3529	0.6875	0.1333	0.3333	0.0667	0.6
Relieve pain	0.1667	0.0556	0.5	0.3529	0.2941	0.8125	0.5333	0.0667	0.4	0.5333
Clear away heat	0.5556	0.5556	0.1667	0	0.2941	0.6875	0.0667	0.3333	0.2	0.5333
Invigorate blood circulation	0.0556	0.2222	0.1667	0.2353	0.1765	0.125	0.1333	0.0667	0.4	0.2667
Dispel endogenous wind	0.1667	0	0.2222	0.0588	0.1765	0.3125	0.4	0.2667	0.4	0.1333
Regulate or enhance energy flow (Qi)	0	0.0556	0.3889	0.4706	0.1765	0.0625	0.3333	0.1333	0.4	0.1333
Reduce swelling	0.1667	0.3333	0.0556	0.0588	0.2353	0.25	0.0667	0.3333	0.3333	0.1333
Whet the appetite or reinforce stomach	0.1667	0	0.1667	0.4706	0.1176	0	0.2667	0.1333	0	0
Nourish, warm spleen, stomach or Qi	0.1667	0	0.2222	0.4118	0	0	0.2667	0.0667	0	0
Dispel endogenous cold	0	0	0.2222	0.4706	0.0588	0	0.4	0	0	0

Note: Only those functions with several greater frequencies are listed here.

Medicinal Functions

排脓/消炎/抗感染 Discharge pus, diminish inflammation or anti-infection 1%

解表/发表 Relieve external syndrome 1%

杀虫/驱虫 Kill or expel parasites 2%

降转氨酶 Reduce aminotransferase 0%

补肾/温肾 Consolidate or warm kidney 1%

利水/行水 Activate water metabolism or excrete water 1%

壮阳/温阳/益精 Invigorate male impotence (Yang) or strengthen male essence 1%

清肺/润肺 Remove lung-heat or nourish lung 2%

止痒 Relieve itching 1%

收敛 Promote astringent function 0%

清肝/补肝/舒肝/明目/退翳 Clean liver, relax liver, consolidate liver, brighten eyes, or remove cataract 0%

利尿/通淋 Induce diuresis or treat strangurt 2%

祛痰/化痰 Eliminate or relieve phlegm 3%

燥湿 Dry dampness 1%

透疹 Expose/fight the eruptive measles 0%

止汗 Suppress perspiration 0%

发汗 Induce perspiration 0%

强筋骨 Strengthen bones and muscles 1%

通鼻窍 Eliminate or relieve stuffy nose 0%

祛肺结核 Eliminate or relieve tuberculosis 0%

祛风湿/利关节 Relieve rheumatism or lubricate the joints 1%

祛寒 Dispel endogenous cold 1%

生肌 Promote granulation 0%

止咳 Eliminate or relieve cough 3%

开胃/益胃 Whet the appetite or reinforce stomach 1%

祛风 Dispel endogenous wind 5%

解暑/消暑 Relieve summer-heat 0%

止渴 Quench ones thirst 0%

降火 Decrease internal heat 1%

祛湿 Dispel endogenous damp 3%

平喘/定喘 Anti-asthma 1%

健脾/补脾 Strengthen and reinforce spleen 1%

生津 Promote secretion of saliva 1%

消食/化积 Improve digestion 1%

醒脑 Refresh body 1%

利咽 Relieve sore throat 0%

止呕 Remedy or prevent vomiting 0%

解毒 Detoxification 9%

辟秽 Remove foulness 0%

强心 Strengthen heart-function 0%

安神 Tranquilize heart-fire 1%

定痫 Relieve epilepsy 0%

利湿 Eliminate dampness 3%

通便 Relieve constipation 0%

润肠 Loosen the bowels 1%

润燥 Moisten dryness 0%

涩肠 Astringe intestine 0%

清热 Clear away heat 10%

凉血 Cool blood 2%

止血 Stop bleeding 3%

补血/补血 Tonify blood 0%

消积/消滞 Resolve food stagnation 1%

活血 Invigorate blood circulation 4%

止痢 Antidiarrheal 0%

抗癌 Anticancer 0%

止痛 Relieve pain 5%

消肿 Reduce swelling 5%

化瘀/消痈/软坚/定神/解郁 Absorb or eliminate clots, eliminate stasis, carbuncle or promote wound healing 4%

解郁/定惊 Relieve restlessness, calm the liver, alleviate mental depression, or arrest convulsion 1%

止泻 Stop diarrheal 0%

散结/软坚 soften hardness or dissolve masses 1%

通络/活络/舒筋 Remove obstruction in meridians and collaterals, or relax the muscles and joints 1%

安胎 Prevent miscarriage or abortion 0%

降压 Antihypertension 0%

降糖 Antidiabetics 0%

温中/和中/补中 Nourish, warm spleen, stomach or Qi 1%

理气/养气 Regulate or enhance energy flow (Qi) 2%

降血脂 Antiatheroscloresis 0%

滋阴 Nourish essential fluid (Yin) 0%

抗衰老 Anti-aging 0%

下气/破气 Inhibit or break energy flow (Qi) 1%

通乳/下乳 Promote lactation or stimulate blood flow 0%

调经/通淋 Regulate menstruation or promote blood flow 2%

Fig. 7 Percentages of different medicinal functions.

4 Discussion

This study undoubtedly presupposes that all recorded attributes of all Chinese herbal medicines are true, at least in the statistical sense. The medicinal properties, taste attributes and chemical composition categories have high reliability. Although various meridians and collaterals are abstract, it is also a conclusive result from countless experiences, which can reflect the characteristics of biological network to a certain extent. The objectivity of medicinal functions, despite the overall recognition by people, but for specific Chinese herbal medicine and specific functions, they still need a lot of empirical test.

Table 11 Composition of major families of world seed plant flora and Chinese herbal medicines in CHM-DATA.

World Seed Plant Flora*			Chinese Herbal Medicines**		
Family	No. Species	%	Family	No. Species	%
Asteraceae	30000	25.44	Asteraceae	93	44.29
Leguminosae	17600	14.92	Labiatae	55	26.19
Gramineae	10000	8.48	Leguminosae	52	24.76
Euphorbiaceae	8000	6.78	Ranunculaceae	38	18.10
Rubiaceae	6000	5.09	Rosaceae	31	14.76
Cyperaceae	4000	3.39	Liliaceae	28	13.33
Labiatae	3500	2.97	Polygonaceae	28	13.33
Rosaceae	3300	2.80	Apiaceae	27	12.86
Cruciferae	3200	2.71	Rubiaceae	21	10.00
Scrophylariaceae	3000	2.54	Euphorbiaceae	21	10.00
Umbelliferae	2800	2.37	Solanaceae	20	9.52
Boraginaceae	2000	1.70	Gramineae	18	8.57
Solanaceae	2000	1.70	Scrophulariaceae	18	8.57
Liliaceae	2000	1.70	Rutaceae	18	8.57
Orchidaceae	2000	1.70	Zingiberaceae	17	8.10
Ranunculaceae	1900	1.61	Asclepiadaceae	17	8.10
Convolvulaceae	1800	1.53	Menispermaceae	16	7.62
Caryophyllaceae	1750	1.48	Lauraceae	15	7.14
Crassulaceae	1600	1.36	Moraceae	15	7.14
Chenopodiaceae	1400	1.19	Araliaceae	15	7.14
Malvaceae	1000	0.85	Papaveraceae	15	7.14
Violaceae	900	0.76	Verbenaceae	12	5.71
Gentianaceae	900	0.76	Caryophyllaceae	12	5.71
Polygonaceae	800	0.68	Aristolochiaceae	12	5.71
Primulaceae	800	0.68	Araceae	12	5.71
Iridaceae	800	0.68	Cucurbitaceae	11	5.24
Geraniaceae	780	0.66	Brassicaceae	11	5.24
Onagraceae	600	0.51	Orchidaceae	11	5.24
Saliaceae	540	0.46	Amaranthaceae	11	5.24
Saxifragaceae	500	0.42	Ericaceae	11	5.24
Caprifoliaceae	450	0.38	Oleaceae	9	4.29
Juncaceae	400	0.34	Amaryllidaceae	9	4.29
Plumbaginaceae	350	0.30	Convolvulaceae	8	3.81
Plantaginaceae	270	0.23	Apocynaceae	8	3.81
Zygophyllaceae	240	0.20	Magnoliaceae	8	3.81
Orobanchaceae	180	0.15	Chenopodiaceae	8	3.81
Cuscutaceae	170	0.14	Berberidaceae	8	3.81
Betulaceae	140	0.12	Celastraceae	8	3.81
Tamaricaeae	120	0.10	Cyperaceae	7	3.33
Potamogetonaceae	100	0.08	Polypodiaceae	7	3.33
Ephedraceae	40	0.03	Malvaceae	7	3.33

*: % is based on species richnses of families in the table' **: % is based on 210 families.

In this study, the number of herb medicines is great, and the dominant families also contain enough number of Chinese herbal medicines, so abovementioned frequency can be used as an estimate of probability. Of course, the more types Chinese herbal medicines have, the more accurate the estimation is.

From Table 11, we conlude that most of the Chinese herbal medicines source from dominant families of seed plants (Pan, 1997), especially the family, Asteraceae. However, a variety of differences between the two lists exist also, which means the targeted and intentional screening of Chinese herbal medicines by people. For example, people tend to screen medicinal plants with cold and bitter attributes than those with warm and sweet attrubutes.

Some implication of network pharmacology can be found from the abovementioned results. As a typical example, the taste attribute, bitter, usually corresponds to the medicinal property, cold, and the chemical composition category, alkaloids, and sometimes the toxicity attribute, toxic. In many cases, of course, an attribute may be determined by several of other attributes. Further studies are needed to expound the complex relationships between attributes, for example, the relationships between external attributes, e.g., taste attributes or medicinal properties, and internal attributes, e.g., chemical composition, or network attributes, e.g., meridians and collaterals. It will bridge a connection between traditional description and network attributes or chemical substances, and thus help to reveal and examine the network pharmacological mechanisms of medicinal functions of Chinese herbal medicines. I will present these results in forthcoming reports.

References

Baidu. 2017. Baidu Encyclopedia. http://baike.baidu.com/. Accessed Feb 1-28, Mar 1-20, 2017

Bao XS. 1997. Practical Alias Handbook of Chinese Traditional Medicines (Revised Edition). Guangdong Science and Technology Press, Guangzhou, China

Budvsky A, Fraifeld VE. 2012. Medicinal plants growing in the Judea region: network approach for searching potential therapeutic targets. Network Biology, 2(3): 84-94

Ding XX. 2009. Medicinal Plants in Northern China. Nanfang Daily Press, Guangzhou, China

Editorial Board of Chinese Flora, Chinese Academy of Sciences. 2004. Chinese Flora. Science Press, Beijing, China

Editorial Board of Chinese Materia Medica, State Administration of Traditional Chinese Medicine of the People's Republic of China. 1999. Chinese Materia Medica. Shanghai Scientific and Technical Publishers, Shanghai, China

Editorial Board of Compilation of National Herbal Medicines. 1975. Compilation of National Herbal Medicines. People's Medical Publishing House, Beijing, China

Hopkins AL. 2007. Network pharmacology. Nature Biotechnology, 25(10): 1110-1111

Hopkins AL. 2008. Network pharmacology: the next paradigm in durg discovery. Nature Chemical Biology, 4(11): 682-690

Li SZ. 2012. Compendium of Materia Medica. China Yan Shi Press, Beijing, China

Nanjing University of Chinese Medicine. 2006. Dictionary of Chinese Traditional Medicines. Shanghai Scientific and Technical Publishers, Shanghai, China

National Pharmacopoeia Commission. 2015. Pharmacopoeia of the People's Republic of China. China Medical Science Press, Beijing, China

Network of Chinese Medicine. 2017. http://www.doctor001.com/. Accessed on Feb 1-28, Mar 1-20, 2017

Pan XL. 1997. Floristic analysis of seed plant families in Xinjiang. Bulletin of Botanical Research, 17(4): 397-402

Query Platform for Promotion of Norms of Chinese Medicines, Terminology, Achievements, and Medical Information. 2017. http://www.statcm.org.cn/. Accessed on Feb 1-28, Mar 1-20, 2017

Wang GQ. 2014. Compilation of Chinese Herbal Medicines (Vol. 1 – Vol. 4) (3rd Edition). People's Medical Publishing House, Beijing, China

Wang SX. 2012. Function of herbal medicine systems of classification and analysis of theacious laws. http://eng.hi138.com/medicine-papers/phapers-papers/201201/371916_Function-of-herbal-medicine-syste ms-of -classification-and-analysis-of-the-inherent-laws.asp # .WNUm-k9vu7E

Wang YS, Cai YW. 2011. Medicinal Plants in Southern China. Nanfang Daily Press, Guangzhou, China

Zhang WJ. 2016a. A method for identification hierarchical sub-networks and weighting network links based on its similarity in sub-network affiliation. Selforganizology, 3(2): 43-53

Zhang WJ. 2016b. Network pharmacology: A further description. Network Pharmacology, 1 (1): 1-14

Zhong Yi Shi Jia. 2017. Chinese traditional medicines. http://www.zysj.com.cn/zhongyaocai/index.html. Accessed on Feb 1-28, Mar 1-20, 2017