Mongolian medicine: History, development and existing problems

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Abstract

Mongolian medicine (MM) is an important part of Mongolian culture. Exploration of MM can play a crucial role in the prevention and treatment of various diseases and can help provide better health care globally. In this article, we gave a brief introduction to the origin and development of MM, the theoretical system of MM, the principles of Mongolian materia medica formula, the modern research on Mongolian materia medica and the quality control of Mongolian materia medica. The present situation and outlook of MM were also discussed.

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CONTENTS

1. Introduction ........................................... 346
2. Origin and development of Mongolian medicine ........................................... 347
3. Theoretical system of Mongolian medicine ........................................... 348
3.1. Three roots or three essences ........................................... 348
3.2. Five elements ........................................... 349
3.3. Six flavors ........................................... 350
3.4. Eight properties ........................................... 350
3.5. Seventeen effects ........................................... 350
3.6. Two powers ........................................... 351
4. Principles of Mongolian materia medica formula ........................................... 351
5. Modern research on several classical Mongolian materia medica formulas ........................................... 352
5.1. Wenguanmu Siwei Decoction ........................................... 352
5.2. Jianghuang Siwei Decoction ........................................... 352
5.3. Gurigumu-7 ........................................... 352
6. Quality control of Mongolian materia medica ........................................... 353
7. Discussion ........................................... 354
Declaration of Competing Interest ........................................... 354
Acknowledgements ........................................... 354
References ........................................... 354

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1. Introduction

Mongolian medicine (MM) is an integral part of Mongolian culture. During the long run of nomadic life, MM had increasingly integrated traditional Chinese medicine (TCM), Tibetan medicine, ancient Indian medicine, and other traditional medical theories and developed over time. Theoretical systems of MM were formed to guide diagnosis, treatment, and medication. In the development of MM, drugs are closely associated with medicine, and an excellent doctor is always an expert in drugs. Therefore, MM is a concept of both medicine and drugs. As an important part of Mongolian culture, MM has become an irreplaceable part of the world medicine as well as Chinese medicine.

Mongolian materia medica is used for describing drugs used in MM and usually originates from natural materials, such as animals, plants, and minerals with less toxic side effect. Based on relevant literature statistics, there are more than 2200 items of Mongolian materia medica, of which about 450 are commonly used, including 313 plant drugs, 66 animal drugs, 48 mineral drugs and 23 others (Nuendagula, 2009). In ancient times, Mongolian people used a single medicine to treat diseases. In long-term practices, they summarized the drug theory of six flavors (six flavors refer to sweet, sour, salty, pungent, bitter and astringent), eight properties (eight properties refer to heavy, greasy, cold, blunt, light, coarse, hot and sharp). Flavors and properties are used for describing natures of medicines), seventeen effects (seventeen effects refer to soft, heavy, warm, greedy, solid, cold, blunt, cool, mild, dry, watery, thin, hot, light, sharp, coarse, and active describe the effects of different medicines), and two powers which effectively guided the use of Mongolian materia medica. Even though the eight properties seem to be included in the seventeen effects, in fact, the eight properties describe the properties or natures of medicines, but the seventeen effects are describing the effect on human bodies, so their connotations are different. Based on the principle of origin, collection, effect, flavors after digestion and compatibility, the relevant drugs were prepared together and effectively played their drug functions, so MM prescription was formed and have been used by doctors of all generations for a long time. MM is still widely used in the modern clinic because its curative effect (Lan et al., 2021). The compatibility of Chebulae Fructus is used to reduce the toxicity of Aconitum Kunzeoffii Radix. The compatibility of Chebulae Fructus and Aconitum Kunzeoffii Radix greatly reduces the content of toxic substances of aconitine, hyaconitine and mesaconitine from Aconitum Kunzeoffii Radix (Li et al., 2021). The compatibility of Chebulae Fructus and Glycyrrhizae Radix and Rhizoma greatly reduces the expression of CYP450 enzyme to reduce the accumulation time of aconitine in the liver of normal rats (Huo et al., 2022). The research on the quality standard of Mongolian materia medica has developed gradually. In the past, traditional knowledge of medicines mainly relied on teaching by precept and example, but now, the state has issued many quality control standards. Some traditional Mongolian materia medica has been included in the Pharmacopoeia of the People’s Republic of China with sufficient quality control methods. For example, the high-performance liquid chromatography (HPLC) method has been applied to determine the content of a galosate IV in Astragali Radix (Fig. 1C), matrine and oxymatrine in Sophora Flavescentis Radix and aconitine, hyaconitine and mesa-

| Table 1 | Six basic syndromes in Mongolian medicine. |
|---------|---------------------------------------------|
| Syndromes | Causes | Symptoms |
| Heyi syndrome | Increase and dysfunction of the Heyi caused by external factors | Frequent yawning, insomnia, wandering pain, shiver, dizziness, tinnitus, retching, and red and dry tongue |
| Xila syndrome | Increase and dysfunction of the Xila due to the improper diet and lifestyle practices | Headache, stomach, thirst, fever, local pain, thick tongue coating, yellow urine with a strong smell, and arrhythmia |
| Badagan syndrome | Increase and dysfunction of the Badagan caused by inappropriate diet, climate and living behavior | Loss of appetite, indigestion, gustatory disorder, nausea, stomach bilges frowsty, depression, feeling of cold, and lethargy |
| Qisu syndrome (Qisu means blood and this syndrome is related to blood symptoms such as blood stasis) | Abnormal increase or decrease of the blood in the human body | Bleeding, anemia, and swelling |
| Xieriwusu syndrome (Xieriwusu means fluid in the articular cavity and this syndrome is related to immune diseases such as lupus erythematosus) | Abnormal increase of the Xieriwusu | Purritus, rash, plaques, and joint swelling |
| Hvvhai sympt (Hvvhai means parasites and this syndrome is related to parasitosis) | Invasion of the parasites into the human body | Headache, stomach, fever, bone soreness, diarrhea and red and swollen skin |

With the development of modern pharmaceutical sciences, researchers are putting their efforts into the extraction and isolation of active compounds, pharmacology research, formulation of quality standards and dosage form reform. The research on the chemical components of Mongolian materia medica has developed rapidly. Modern chromatographic separation techniques, spectral analysis and other technologies are used to determine the chemical components of Mongolian materia medica. Almost half of the prescriptions of MM contain Chebulae Fructus, which is also known as “the king of Mongolian medicines” (Fig. 1D). Phenolic acids, tannins, triterpenoids, aliphatics, flavonoids, and volatile oils have been extracted and determined from Chebulae Fructus. In the pharmacological research of Mongolian materia medica, many modern pharmacological interpretations of traditional efficacy have been raised. In MM, Chebulae Fructus is used to reduce the toxicity of Aconitum Kunzeoffii Radix. The compatibility of Chebulae Fructus and Aconitum Kunzeoffii Radix greatly reduces the content of toxic substances of aconitine, hyaconitine and mesaconitine from Aconitum Kunzeoffii Radix (Li et al., 2021). The compatibility of Chebulae Fructus and Glycyrrhizae Radix and Rhizoma greatly reduces the expression of CYP450 enzyme to reduce the accumulation time of aconitine in the liver of normal rats (Huo et al., 2022). The research on the quality standard of Mongolian materia medica has developed gradually. In the past, traditional knowledge of medicines mainly relied on teaching by precept and example, but now, the state has issued many quality control standards. Some traditional Mongolian materia medica has been included in the Pharmacopoeia of the People’s Republic of China with sufficient quality control methods. For example, the high-performance liquid chromatography (HPLC) method has been applied to determine the content of a galosate IV in Astragali Radix (Fig. 1C), matrine and oxymatrine in Sophora Flavescentis Radix and aconitine, hyaconitine and mesa-
conitine in Aconitum Kusnezoffii Radix. For those Mongolian materia medica which have not been included in the Pharmacopoeia of the People’s Republic of China, studies are continuously being carried out to promote the promulgation of regional quality standards. For example, researchers in Inner Mongolia Medical University have published Study on Quality Standards of Mongolian Materia Medica. The research on dosage form reform has made many achievements. Medicines of traditional dosage forms have already been circulated on the market. Garidi Wuwei Pill (it consists of Chebulae Fructus, Moschus, Aconitum Kusnezoffii Radix, Aucklandiae Radix and Aceri Tatarinowii Rhizoma and has anti-inflammatory and analgesic effects) as well as Zhenbao Pill (it consists of 29 medicines including Margarita, Gypsum Fibrosum, Caryophylli Flos, Carthami Flos, Inulae Radix etc. and has the effect of reducing blood pressure as well as neuroprotection) are two of the most popular Mongolian medicines available in the market. Based on the 10 traditional dosage forms, more than 10 new dosage forms including injections, dropping pills, tablets, capsules, plaster agents, spray, suppository, detergent, granules, and oral liquid have been included, just like the Guanxin Shutong Capsule and Baolier Capsule. These dosage forms fulfill the characteristics of low toxicity and high efficiency.

However, compared with TCM, MM is still in a weak position. The deficiencies can be summarized as insufficient in-depth research on the material basis of Mongolian materia medica, unsystematic research on the pharmacology, toxicology, and pharmacokinetiks of Mongolian materia medica, unclear interpretation of the compatibility principles of Mongolian materia medica, and slow progress in the development of new Mongolian medicines. In terms of quality control, after more than 30 years of scientific and technological development, the contents of active compounds need to be included in the standards. New technologies and methods should be used to formulate new standards of Mongolian materia medica.

2. Origin and development of Mongolian medicine

The origin and development of MM can be classified into the following four stages: The germination and experience accumulation stage before the 13th century, the theoretical formation stage between the 13th and 16th Century, the rapid development stage between the 16th and 20th Century, and the leap development stage from the mid-20th Century to present (Menghe et al., 2021).

Before the 13th century, nomadic tribes that were scattered on the Mongolian plateau (northern part of today’s China) started to accumulate their medicinal experiences and the theoretical knowledge began to sprout. A bloodletting therapy method from the Mongolia region (Fig. 2B, Han is one of the dynasties in China from 202 BC to 220 AD and the Book of Han is a set of biographical history books mainly finished by Ban Gu (32–92 AD) in 105 AD, recording the stories of emperors and principal officials of Han,) and Xianbei (one of an ancient nationalities in northern China) was recorded to use moxibustion to cure diseases in the Records of the Three Kingdoms (Fig. 2C, the Three Kingdoms refer to Wei, Shu, Wu, three major kingdoms existing from 220 A.D. to 280 A.D. and the Records of the Three Kingdoms is a set of biographical history books written by Shou Chen (233–297 A.D.) from 280 A.D. to 290 A.D., recording the stories of emperors and principal officials of each kingdom), in the famous work of Qianjin Yuqofang (Fig. 2D, the book means valuable prescriptions and is a classic work of TCM written in around 652 A.D. by a great doctor called Simiao Sun). Xiongnu Lusu Pill, a medicine named after an ancient ethnic group Xiongnu (Xiongnu is also called Huns and distributed in northern China from 318 B.C. to nearly 300 A.D.) was included with the function of warming the body up. In the masterpiece of the Secret History of Mongols (Fig. 2A, the book tells the history of the formation, development and growth of the Mongolian written in 13th–14th Century), the positive health effects of fermented milk from mare were recorded and nowadays, people also drink it for health purposes. All these experiences and knowledge set the foundation for the formation of the theoretical system of MM.

In the 13th century, all the nomadic tribes on the Mongolian plateau were united under the name of Mongols and the establishment of the Mongol Empire across Eurasia greatly promoted communications among different ethnicities. Strengthened cultural integration provided a foundation for the formation of theoretical system for MM. Just then, huge progress was made in MM. Ancient Mongolians galloped on the battlefield all year round and wounds like cataclasis could easily occur. This greatly promoted the advancement of bonesetting. Yinshan Zhengyao (Fig. 3, it means principles of correct diet) was written in 1330 by Husihui (He worked as imperial physician in charge of Emperors’ diet from 1314 to 1329). It is the first complete monograph on nutrition and food hygiene in China. Cold and Heat Theory was also established on clinical experiences at that period. The theory demonstrated that all diseases can be divided into cold and heat. When treating cold disease, medicines with hot properties will be used and vice versa. The properties were further developed into six flavors, eight properties and seventeen effects with a deeper understanding of diseases and medicines.

From the 16th century, rapid progression can be seen in MM because of the introduction of Sibu Yidian (an encyclopedia of Tibetan medicine with four volumes written during the 8th Century, which included classification of diseases, physiology, pathology, diagnosis and treatment, and drug formulation) into Mongolia regions. During the late 17th Century, an Indian medicinal book, Astangahrdaya Samhita (estangahrdaya Samhita is a set of Indian medicine books with six volumes and 120 chapters which included the development of human bodies, physiology, disease and treatment) was also been introduced into Mongolian regions. Foreign

Fig. 1. Some commonly used crude drugs in MM. A: Glycyrrhizae Radix et Rhizoma is the main medicine in Gancao Liuwei Powder. B: Gymnadeniae Rhizoma is the main medicine in Shouzhangshen Bawei Decoction. C: Astragali Radix is widely used in Mongolian medicine as well as TCM as diuretic and discutient drug. D: Chebulae Fructus, known as “the king of Mongolian medicines”, plays the role of main medicine in many prescriptions.
Medical knowledge is gradually integrated into MM. A number of Mongolian medical experts emerged and many great Mongolian medical books were completed during this period (Tables 2 and 3, Fig. 4).

Since the middle of the 20th century, MM has entered the era of leaping development. The MM culture inheritance, personnel training, scientific research, discipline construction, platform construction and international cooperation have been booming. Undergraduate education of MM began in 1958 and postgraduate education of MM then began in 1985. In recent years, the national medical industry has developed rapidly and has been highly valued by the state and governments. In November 2014, the $40 billion “Silk Road Fund” invested by the Chinese government was established. The Inner Mongolia government has issued several policies to support and promote the development of MM and activate the potential of MM development. According to related policies, by 2020, people of Inner Mongolia autonomous region has already enjoyed MM and TCM services evenly. Under the support of the Belt and Road initiative and related policies, MM has been ushered in an opportunity for great development.

3. Theoretical system of Mongolian medicine

MM as an important part of Mongolian cultural heritage has been used for health care and playing an important role of Mongols. Theoretical systems of MM were formed to guide diagnosis, treatment, and medication. The basic theory of MM can be summarized as three roots, five elements, six flavors, eight properties and seventeen effects, two powers (Ao, 2019).

3.1. Three roots or three essences

MM developed its special core basic theory called the three roots (or three essences) which refers to Heyi, Xila and Badagan. The three roots are not only the main material basis of human body, but also the important energy and power of human life activities. Heyi reflects the intrinsic motivation for the human body’s breathing, blood circulation, metabolic function, mental and physical activities and all life movement. It has the features of light,
coarse, active, cool, tiny, and firm. Xila is mainly distributed in the human liver, gallbladder, and blood and is the source of body temperature, with the functions of regulating body temperature, promoting digestion, increasing appetite. It has the features of hot, sharp, greasy, light, smelly, fluid, and wet. Badagan means viscous moting digestion, increasing appetite. It has the features of hot, sharp, greasy, light, smelly, fluid, and wet. Badagan syndromes, Table 1). During treatment, we need to adjust the three roots, restore their original relative balance and make the lives get normal.

3.2. Five elements

In MM, five elements refer to Earth, Water, Fire, Gas and Space. Earth sets the foundation for plant growth. Based on Earth, plants get nutrients for their growth. Water is the liquid medium for plant growth. Nutrients dissolve in Water and thus can be transported to different proportions in human bodies. When the equilibrium is disrupted by diet or some factors, Heyi, Xila and Badagan have the possibility of excessive increase or loss, resulting in loss of coordination and in turn, become pathological (Heyi, Xila and Badagan syndromes, Table 1). During treatment, we need to adjust the three roots, restore their original relative balance and make the lives get normal.

### Table 2
Mongolian medical pharmacists and their achievements from past dynasties until present.

| Names of pharmacists | Birth and death | Main achievement |
|----------------------|-----------------|------------------|
| Huisibai             | 13th–14th Century | Compilation of Yinshan Zhengyao |
| Hugongtai            | Around 14th Century | Compilation of Jinlan Xunjing |
| Shatumsu             | Around 14th Century | Compilation of RuiZhu Yang Jingyan Fang, etc |
| Namuhaizamusu        | 1599–1662        | Translator of Sibu Yidian |
| Mengenchurzi         | 16th–17th Century | Master of Bone Setting |
| Luobsangdanseng      | 1639–1704        | Great Pharmacist |
| Ixibalajar           | 1704–1788        | Compilation of Ganlu Sibu, etc |
| Luobsangchultem      | 1740–1810        | Compilation of Ren Yao Xue |
| Zhambalaquejdanspurenla | 1798–1838    | Compilation of Mijue Fanghai, etc |
| Zhanbuldaorji        | 1792–1855        | Compilation of Mengyao Zhi, etc |
| Ixibangsangwangjila  | 1853–1906        | Compilation of Shunhu Yanfang, etc |
| Qingyun Bai          | 1912–1989        | Contemporary Medical Scientist |
| Surongzhab           | 1929–2014        | Contemporary Medical Scientist |
| Luobsang             | 1932–2007        | Contemporary Master of Chinese Medicine |
| Jigemude             | 1938–          | Contemporary Master of Chinese Medicine |
| Bao Jinshan          | 1939–          | Contemporary Master of Chinese Medicine |

**Table 2**

### Table 3
Most influential books revealing formation and development of classical prescriptions in Mongolian medicine.

| Books                          | Authors                  | Production year | Main contents                                                                                     | Comments |
|--------------------------------|--------------------------|-----------------|---------------------------------------------------------------------------------------------------|----------|
| GanLu ZhiQuan                  | Ixibalajar               | 1751            | Introduction to the origin, physiology, pathology, treatment principles of Mongolian medicine and six basic symptoms. | Widely spread across other countries and regions, playing a significant role in the development of Mongolian medicine. |
| GanLu DianDi                   |                          | 1752            | Discussion of the disease and syndrome, important causes of diseases and treatment principles, indicating Raising Marmot as one of the sources of transmission of plague. |          |
| GanLu JieJing                  |                          | 1759            | Discussion of six basic symptoms and ten main symptoms, compilation of routine medication.          |          |
| GanLu QingYan                  |                          | 1785            | Discussion of the cure of six basic symptoms and ten main symptoms influenced by age, gender, and other factors. |          |
| Mijue FangHai                  | Zhambalaquejdanspurenla  | 1829            | Compilation of nearly 2000 prescriptions and introduction to the composition, taste, dosage, preparation method and the main therapeutic function of each prescription were introduced. | A relatively complete collection of Mongolian medicine prescriptions. |
| Selections of Mongolian Medicine | Luobsangchultem         | 18th Century    | A comprehensive medical work mainly focusing on the clinical practice of Mongolian medicine that briefly describes Mongolian medicine, prescriptions, and therapeutics. | Widely spread across Russia, Mongolia and China and played an important role in promoting the development of medical and health systems in these countries. |
| ShantHu YangFang               | Ixibangsangwangjila      | 1868            | Introduction to 99 diagnosis and treatment methods of common diseases in different departments. | Summary of the previous clinical experience of Mongolian medicine and enriches the treatment and prescriptions. |
| GuanZhe ZhiXi                  | Jgemuddanzhamsu          | 1888            | Medicines are divided into 10 categories according to their properties and sources, and the pharmacological effects of 322 drugs are summarized and recorded. | Contributes to the medical and health undertakings of the people. |
different parts of the plant body. Fire is the energy for the matura-
tion of plants. Sunshine and warm temperature can also provide
external Fire. Gas is more like pressure and bears the ability of dif-
fusion and motivation. It is the intrinsic power to push the trans-
portation of Water and Fire to promote plant growth. Inside the
plants, Space forms the channel in which Water carries nutrients
to different parts in the plant body and for outside, it refers to
the space for existence of everything. The production of medicine
is closely associated with soil, water, sunshine, air, and other nat-
ural conditions. During the development of all kinds of medicines,
all five elements participate differently to form different medicines
in terms of flavors, properties, effects due to the different par-
ticipation of the five elements.

3.3. Six flavors

In TCM, five flavors are raised to describe the flavor of medi-
cines. Based on sweet, sour, salty, bitter and pungent in TCM, Mon-
golian medicine added astringent as the sixth flavor. They are
generated by two elements which are abnormally strong during
the formation of medicine. If Earth and Water are strong, the flavor
is sweet, if Fire and Earth are strong, the flavor is sour, if Water and
Fire are strong, the flavor is salty, if Water and Gas are strong, the
flavor is bitter, if Fire and Gas are strong, the flavor is pungent and
if Earth and Gas are strong, the flavor is astringent. The sweet med-
icine has the function of nourishing the body. The sour medicine
can strengthen the spleen as well as the stomach and help diges-
tion. The salty medicine can warm the spleen as well as the stom-
ach and stimulate appetite. The bitter medicine has the effects of
clearing heat and liver-detoxification. The pungent medicine can
warm the body and invigorate the stomach. The astringent medi-
cine can moisten the skin and cool the body. In terms of the com-
prehensive efficacy of pharmaceutical flavors, the sweet, sour,
salty, and pungent flavors can suppress Heyi, the sweet, bitter,
and astringent flavors can suppress Xila and induce Badagan, the
sour, salty, and pungent flavors can suppress Badagan and Xila
and the bitter and astringent flavors can induce Heyi. In addi-
tion, there are also “three flavors” in MM. In MM, the original fla-
vors of the medicine will change during the process of digestion
by the human body. That is, the salty flavor becomes the sweet fla-
vor, the pungent and astringent flavors become bitter, the sweet,
bitter, and sour flavors are constant, so the final flavor is sweet, bit-
ter and sour after the digestion of six flavors. Therefore, the “three
flavors” refers to the medicine flavors after digestion.

3.4. Eight properties

Eight properties describe the properties of medicines include
heavy, greasy, cold, blunt, light, coarse, hot, and sharp. In MM,
the heavy and greasy drugs are used for Heyi, namely treating
trance, dizziness, tinnitus, insomnia, forgetfulness, lethargy and
paralysis; the cold and blunt drugs are mainly used for Xila,
namely treating fever, polydipsia, diarrhea, jaundice and liver
gallbladder diseases; the light, coarse, hot and sharp drugs
are used for Badagan, namely treating the body coldness, psycho-
somatic heaviness, loss of appetite, indigestion, vomiting, diarrhea,
wheat and knee pain, sleepiness, obesity and other cold diseases.

3.5. Seventeen effects

Seventeen effects describe the functions of medicine including
soft, heavy, warm, greasy, solid, cool, dull, cold, mild, watery, dry,
thin, hot, light, sharp, rough, and moving. For example, Heyi syn-
drome always shows symptoms of dizziness. In MM, light means
your spirit is light instead of heavy and excessive light cannot sta-
bilize your spirit inside your body, thus triggering dizziness. At the
time, medicines with heavy effect need to play their role to balance
the excessive light to treat dizziness. Most of them are produced
from the six flavors and eight properties of medicine. These effects
have a restraint or breeding relationship with the 20 features
of Heyi, Xila, Badagan syndromes (six of Heyi, seven of Xila, seven
of Badagan and the relationship between of Heyi, Xila, Badagan
syndromes and the flavors, properties, effects of their symptomatic
medicines can also be found in Table 4). The relationships are as
follows: in the treatment of Heyi, the soft can restrain the coarse,
the heavy can restrain the light, the warm can restrain the cool,

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**Fig. 4.** Great Mongolian medical books were completed at the rapid development stage from 17th to 20th century. A: *GanLu SuBu* means the books of Mongolian medicines with four volumes compiled by Ixibalajur (1704–1788). It systematically stated human physiology, pathology, diagnostic methods, treatment principles and methods and medical ethics, laying the foundation for Mongolian medicine theory and is known as the classic works of MM. B: *MiJue FangHai* means important knowledge of Mongolian medicines and was compiled by Zhambalaquejidansenpurenlai in 1829 and contains 2528 kinds of prescriptions, detailing their formula, preparation method, dosage and efficacy. C: *MengYao ZhengDian* means the canon of Mongolian medicines and was compiled by Mongolian pharmacist Zhanbuldaorji (1792–1855) with 879 kinds of Mongolian materia medica which were classified and recorded according to the source of medicines, growth environment, medicinal part, collection time, processing methods, flavors, properties, effects, as well as the authenticity. This book was written in 18th to 19th century, combining medical theories from Tibetan and Indian medicine.
the greasy can restrain the tiny and firm, and the solid can retrain the active. In treatment of Xila, the cool can restrain the greasy, the blunt can restrain the sharp, the cold can restrain the hot, the mild can restrain the light, the watery can restrain the smelly, and the dry can restrain the damp. In treatment of Badagan, the thin can restrain the greasy, the light can restrain the cold, the heavy can restrain the hot, the sharp can restrain the blunt, the coarse can restrain the soft and sticky, and the active can restrain the hard. According to different diseases, MM chooses the seventeen-effect drugs to treat diseases caused by the unbalance of the three elements and brings them on track, thus achieving the purpose of treating diseases.

3.6. Two powers

Two powers refer to the hot or cold power of medicines. In ancient times, Mongolian people believed that everything contained two opposite aspects and in terms of medicine, syndromes can be divided into hot and cold syndromes. Cold-power medicine is used to treat the hot syndromes and vice versa (Yixi, 2007). Medicines with hot power grow mostly in warm and hot areas or places with sufficient sunshine, thus they possess the hot power. Heyi and Badagan syndromes and dyspepsia can be treated with hot power medicines, but side effects such as dizziness, headache and fever can be triggered when using hot-power medicines. Medicines with cold power grow mostly in cold areas or shady places, so they possess the cold power. Xila syndromes can be treated with cold power medicines, but side effects such as dyspepsia and body rigidity.

4. Principles of Mongolian materia medica formula

The principles of Mongolian materia medica formula are mainly depended on the flavors, the flavors after digestion (they refer to three flavors which mean the salty flavor becomes the sweet flavor, the pungent and astringent flavors become bitter, the sweet, bitter and sour flavors are constant, so the final flavor is sweet, bitter and sour after the digestion of six flavors) and the effects of the medicines. Flavor formulas consider the original flavors of each medicine and are widely used in decoctions. For example, SanWei BangYao Decoction (it consists of Swertiaceae Herba, Gentianae Flos and Ophiopogonis Radix) can treat Heyi syndromes due to the bitter flavor of Swertiaceae Herba, Gentianae Flos and Ophiopogonis Radix in it. Flavor-after-digestion formulas consider the three flavors of medicines after digestion. After digestion, the sweet flavor can reduce Heyi and Xila, the sour flavor can reduce Badagan and Heyi and bitter flavor can reduce Xila. For example, after digestion BaiWei ShiLiu Powder (it contains eight medicines including Puniceae Granati semen, Myristicae semen, Cinnamomi Cortex, Piperis Longi Frutus, Zingiberis Rhizoma and so on) turns into sour flavor and reduces excessive Heyi and Badagan. Formulas prescribed with effects is the most widely used clinical method today. The seventeen effects and unique functions of medicines can be used as the basis for this formulation principle. When treating eye and ear diseases, Phellodendri Chinese Cortex is mostly recommended to be included in the formula for its beneficial effects to eyes and ears.

In clinical application, under the guidance of theories, several suitable drugs are chosen and combined in the right proportions and then made into certain dosages according to different syndromes and principles. When the drug’s flavors and symptoms perfectly match, the medicine is the most effective for the disease. Mongolian materia medica formulas depend on flavors, properties, and effects. These methods are not a simple accumulation of flavors, properties or the effects of the medicine, but a combination of main medicines and adjuvant medicines (Bagana, 2007).

The main medicines play an important role in treating the disease, such as nutmeg for heart Heyi, Glehniae Radix for the lung heat, Bovis Calculus for the liver heat and the white cardamom for the kidney Heyi. Generally, there are only one or two kinds of main medicine in a prescription usually with a high dosage. Adjuvant medicines play the role of strengthen the efficacy of main medicine, restrain the toxicity, treat the minor symptoms and so on, and the dosage is usually the same or slightly less. For example, Chebulae Fructus is used to reduce the toxicity of Aconitum Kunzeoffii Radix. Some classical formulas are listed in Table 5.

To summarize, the formulas of Mongolian materia medica must follow the basic principles above and the coordination of main and adjuvant medicines. After reasonable compatibility, the effect of one single medicine can be strengthened or changed, toxicity can be restrained and negative effects can be removed or alleviated making the complete use of the medicine to achieve optimum clinical effects.

5. Modern research on several classical Mongolian materia medica formulas

Much effort and progress have been made in research on Mongolian materia medica since 1950s especially over the past 40 decades. Some examples of the classical Mongolian materia medica formulas are summarized in the following sections.

5.1. Wenguanmu Siwei Decoction

Wenguanmu Siwei Decoction is one of the classical Mongolian materia medica formulas in MM. It contains Xanthochorae Sorbilofiae Lignum, Toosendan Fructus, Gardeniae Fructus and Chebulae Fructus. It has the effect of heat clearing, anti-inflammatory, detumescence and pain relieving and has a wide range of indications such as gout, hot “xieriwusu” disease (Table 1), hair loss, rheumatic heart disease, joint pain, lymphadenopathy. Active compounds, such as (2R,3R)-dihydromyricetin, myricetin, crocin-3, gallic acid, oleanolic acid, palmitic acid, β-sitosterol and ellagic acid, corilagin, crocetin 1, geniposide furural acid, quercetin, rutin, chlorogenic acid, luteolin, catechin, and epicatechin, were isolated from Wenguanmu Siwei Decoction (Fig. 5) (Pu et al., 2020; Song, Bai, Dong, & Ma, 2015). Xanthochorae Sorbilofiae Lignum also known as Wenguanmu (Borigjidad, 2014) in Chinese is used as the main medicine in Wenguanmu Siwei Decoction. Thirty-three compounds such as flavonoids, terpenoids, anthraquinones, and ster-

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**Table 4**

| Syndromes | Features of each syndrome | Flavors of symptomatic medicines | Properties of symptomatic medicines | Effects of symptomatic medicines |
|-----------|---------------------------|----------------------------------|-------------------------------------|-------------------------------|
| Heyi      | Light, coarse, active, cool, tiny and firm | Sweet, sour, salty, and pungent | Heavy and greasy, Cold and blunt | Soft, heavy, warm, greasy, solid, Cold, blunt, cool, mild, dry, watery |
| Xila      | Hot, sharp, greasy, light, smelly, fluid and wet | Sweet, bitter and astringent | Light, coarse, hot and sharp | Thin, hot, light, sharp, coarse, and active |
| Badagan   | Greasy, cold, heavy, slow, soft, hard and sticky | Sour, salty, and pungent | | |

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S. Qu, J. Bao, W. Ao et al. Chinese Herbal Medicines 14 (2022) 345–355
Introduction of classic formulas of Mongolian medicine.

In ancient times, Mongolian medicine has developed a wealth of treatment formulas with a long history and unique characteristics, among which Wenguanmu Siwei Decoction is an important representative formula. It is a formula that combines two ancient Chinese medicinal herbs, Carthamus tinctorius and Sibbudo Fructus. Wenguanmu Siwei Decoction is frequently used in the treatment of rheumatoid arthritis, liver disease, and diabetes. It is also widely used in modern medicine for its anti-inflammatory and anti-oxidative effects. The formula contains several key active compounds, such as dihydromyricetin and myricetin, which have been found to be of high content in X. sorbifolia. These compounds play a significant role in the therapeutic effects of the decoction.

Table 5

| Prescriptions                  | Sovereign medicine | Other medicines                                  | Functions                              | Indications                                      |
|--------------------------------|--------------------|--------------------------------------------------|----------------------------------------|--------------------------------------------------|
| Wenguanmu Siwei Decoction      | Xanthocerasi Sorbi | Toosendan Fructus, Gardeniae Fructus, Chebulae Fructus | Anti-inflammatory, detumescence, pain relieving | Gout, hot "Kieriwusu" disease, hair loss, yellow water sore, rheumatic heart disease, joint pain, lymphadenopathy |
| Shouzhangshen Bawei Decoction  | Gymmadeniae Rhizoma| Chebulae Fructus, Toosendan Fructus, Gardeniae Fructus, Sophora Flavescentis Radix, Eucommiae Cortex, Os Droconis, Violar Herb | Dampness drying, pain relieving           | Oral erosion, purple and swollen legs            |
| Jianghuang Siwei Decoction     | Curcumae Longae Rhizoma| Tribuli Fructus, Gardeniae Fructus, Phellodendri Chinensis Cortex | Heat clearing, diuresis                | Hematuria, anuria, frequent urination            |
| Zhenbao Pill                   | Margarita           | Bovis Calculus, Gypsum Fibrosum, Caryophylli Flos, Carthami Flos, Inulae Radix and so on | Reducing blood pressure, neuroprotection | Memory loss, cognitive impairment, nerve paralysis, brain and spinal cord damage |
| Gurigumu-7                     | Carthami Flos       | Chebulae Fructus, Ephedrae Herba, Gypsum Fibrosum, Akebiae Caulis, Violae Herba, Scabiosa Flos | Heat clearing, blood cooling             | Hepatic pain, jaundice                         |

Fig. 5. Major active compounds isolated from Wenguanmu Siwei Decoction.

Fig. 6. Ethanol extract of X. sorbifolia effectively restrained various inflammatory factors of rheumatoid arthritis (Jia et al., 2021).

According to Drug Standards for Mongolian Medicines formulated by the Ministry of Health of the People's Republic of China, Wenguanmu Siwei Decoction is only specified in its dosage, with 500 g Xanthocerasi Sorbiolae Lignum, 300 g Toosendan Fructus, 100 g Gardeniae Fructus, 100 g Chebulae Fructus and is expected to have its modern quality control measures.

5.2. Jianghuang Siwei Decoction

Jianghuang Siwei Decoction was documented originally in the Sibu Yidian, which exhibited beneficial effects on diabetic nephropathy via combined synergistic action of multiple formula components including Tribuli Fructus, Gardeniae Fructus, Phellodendri Cortex, and Curcumae Longae Rhizoma (Lai et al., 2018). Eleven major compounds including obacunone, obaculactone, wogonin, vanillic acid, demethoxycurcumin, palmatic acid, curcumin, berberine hydrochloride, bisdemethoxy, curcumenol and genipin gentiobioside were isolated (Fig. 6) (Gao, Yang, & Dong, 2014).

Jianghuang Siwei Decoction treatment significantly reduced the levels of blood glucose, serum creatinine, blood urea nitrogen, urine microalbumin, serum uric acid and reduced renal fibrosis. Jianghuang Siwei Decoction treatment further significantly reduced serum TGF-β1 levels and downregulated the expression of HIF-1α, VEGF and TGF-β1 at both mRNA and protein levels to significantly ameliorate renal damage in diabetic nephropathy mice. Another research showed that Jianghuang Siwei Decoction combined with another two Mongolian medicines, Sugmul-10 and Naremmandul-11, can protect renal through regulating MMP-2 and TGF-β1 (Wang, A, Liu, Wang, & Wei, 2015).

Jianghuang Siwei Decoction was also included in the Drug standards for Mongolian Medicines formulated by the Ministry of Health of the People's Republic of China. The prescription is 25 g Curcumae Rhizoma, 25 g Tribuli Fructus, 20 g Gardeniae Fructus, 15 g Phellodendri Cortex and lacks modern quality control measures.

5.3. Gurigumu-7

Gurigumu-7 is an important Mongolian materia medica formula frequently used for liver diseases. Gurigumu is the flower of Carthamus tinctorius L. (Carthami Flos) and plays the major role in Gurigumu-7. Together with Gurigumu, other six individual
medicines, Ephedrae Herba, Gypsum Fibrosum, Akebiae Caulis, Violae Herba, Chebulae Fructus and Scabiosae Flos comprised the Gurigumu-7. Active compounds in Gurigumu-7 are a complex combination of flavonoids (Wang, Tang, & Zhang, 2015), phenolic acids (Wang et al., 2015), triterpene compounds (Ji, Li, & Ma, 2014), alkaloids like ephedrine. The compounds with hepatoprotective activities were proved to be triterpene compounds, phenolic acids and flavonoids in the methanol eluted fraction of Gurigumu-7 (Xu et al., 2016).

In Gurigumu-7, Chebulae Fructus is another important medicine. According to the existing data, Chebulae Fructus is present in nearly half of Mongolian medicine and is known as the “king of Mongolian medicine”. It is not only used within the Mongolian people, but also gradually applied throughout the world. It has the effects of dispelling wind, dehumidification, dispersing cold and relieving pain. Tannins are the main components of Chebulic acid, chebulagic acid, terchebin and gallic acid (Fig. 7) (Gao et al., 2016).

Research reported that Chebulic acid in Gurigumu-7 had convincing protective effects on the CCl₄-induced acute liver injury by enhancing the anti-oxidative defense system, ameliorating inflammatory responses and inhibiting hepatocyte apoptosis (Li et al., 2020). In addition, some non-traditional medicinal functions have been reported. In vitro pharmacodynamic experiment demonstrated that the effective components of Chebulic acid possessed significant antibacterial effects, and were nontoxic and safe (Li et al., 2016). In another study, the ethyl acetate fraction of Chebulic acid was proved to exhibit an anti-diarrhea effect (Sheng et al., 2016).

The quality standards of Gurigumu-7 are also formulated in Drug Standards for Mongolian Medicines formulated by the Ministry of Health of the People’s Republic of China. However, some modern studies have been carried out to give specific recommendations on quality control of Chebulic acid. A study suggested chebulagic acid, chebulic acid and 1,2,3,4,6-penta-O-galloyl-β-D-glucose to provide good references for the quality assessment of Chebulic acid. The total ratio of the three compounds above may offer a guideline for determining quality of the drug: lower-grade ratio (12.4 ± 6.0), medium-grade ratio (8.8 ± 7.9), higher-grade ratio (3.2 ± 0.8) (Juang & Sheu, 2005).

6. Quality control of Mongolian materia medica

During the past, traditional knowledge of medicines mainly relied on teaching by precept and example from elder pharmacist and now, the state has issued many quality control standards. At present, standards for Mongolian materia medica are set in 1980s. The Inner Mongolia Mongolian medicinal material standard was published in 1986. In 1998, the Mongolian medicine volume for Drug standards of the Ministry of Health of the People’s Republic of China was published. However, limited to the scientific research conditions and level at the time, these standards are more descriptive, with few quantifiable indexes. The standards are lagging for a long time, which restricts the supervision and inspection of Mongolian materia medica and severely affects the use and development of new drugs. For example, in the Mongolian medicine volume for Drug standards of the Ministry of Health of the People’s Republic of China, microscopic identification is the only quality control method for seeds of Cynanchum thesioides without

![Fig. 6. Major active compounds isolated from Jianghuang Siwei Decoction.](image1)

![Fig. 7. Major active compounds isolated from Chebulic acid.](image2)
Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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