

Advances in Application of Bistortae Rhizoma in Mongolian Medicine and Traditional Chinese Medicine

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Abstract Mongolian medicine and traditional Chinese medicine have different interpretations of Bistortae Rhizoma, including its name, nature and taste, function and efficacy. This paper sorted out the related application of Chinese and Mongolian medicine from the records of *Materia Medica*. The chemical components and pharmacological effects of Bistortae Rhizoma were summarized to provide a reference for the clinical application of Bistortae Rhizoma in traditional Chinese medicine and Mongolian medicine, and for the better development and utilization of national medicines.

Key words Bistortae Rhizoma, Functions and indications, Ancient literature records, Chemical components, Pharmacological effects

1 Introduction

The traditional Chinese medicine and Mongolian medicine Bistortae Rhizoma is the dried rhizome of *Polygonum bistorta* L. which is mainly distributed in Inner Mongolia, Shandong, Gansu, Hubei, Jiangsu, Hubei of China, and Mongolia, Russia, Japan and Korea. Bistortae Rhizoma is one of the widely used medicinal plants in clinical prescriptions of Mongolian medicine and traditional Chinese medicine. Based on the completely different usage, dosage and compatibility of Bistortae Rhizoma in the two medical theoretical systems, we aim to collate and compare the relevant contents on the basis of clinical application of traditional Chinese medicine and Mongolian medicine. In this paper, we briefly introduced the chemical components and pharmacological effects of Bistortae Rhizoma, so as to provide a basis for further investigation of ethnic medicine of Bistortae Rhizoma.

2 Functions and indications

Bistortae Rhizoma has been applied in both Mongolian medicine and traditional Chinese medicine, but its application is different in different theoretical systems. Different ethnic groups have different names for the same medicinal plant, and there are also differences in nature and taste. In Mongolian medicine: Bistortae Rhizoma is also known as Gaduri, Ligaduri, Xibaguan-Sag, Maogaiyin-Tarimu, Daolai, Wuheri-Mogeri, etc., it is cool in nature, astringent and pungent in taste, and has the effects of clearing lung-heat, stopping diarrhea, detumescence, detoxification, and drying Xieriwusu (yellow water)^[1]; indications: lung heat, hemoptysis,

febrile diarrhea, intestinal pain, sore throat and other diseases. In traditional Chinese medicine, there are many other names of Bistortae Rhizoma, such as Zishen, Caoheche, Daoxianyao, Tongluo, Xiashen, Dixia, Shanxiazhi, Hongsaixiu, Shanliuliu, Poshangyao, Huitoushen, Mumeng, Zhongrong, and Hongchongliu^[2], and it is slightly cold in nature, bitter and astringent in taste, and can clear away heat and toxic materials, reduce swelling, stop bleeding, eliminate carbuncles and dissipate stagnation, stop diarrhea and treat dysentery, arrest convulsion and wind^[3]; indications: treating dysentery, diarrhea, acute gastroenteritis, acute respiratory tract infection, oral ulcer, hemorrhoid hemorrhage, venomous snake bite, enteritis, dysentery, hepatitis, carbuncle swelling, hemorrhoid swelling and pain, febrile convulsion, tetanus, dysentery with purulent blood, venomous snake bite, damp-heat diarrhea, stomatitis, and pharyngolaryngitis.

3 Records in ancient literature

The records of application of Bistortae Rhizoma in Mongolian medicine and traditional Chinese medicine are listed in Table 1.

4 Chemical components

At present, more than 100 compounds have been isolated and identified from Bistortae Rhizoma, which mainly contain organic acids, phenols and volatile oils, and few contain flavonoids, terpenoids, alkaloids and glycosides. Organic acids and phenolic compounds in Bistortae Rhizoma were identified and determined by TLC in *Chinese Pharmacopoeia* (2020 edition), and gallic acid was the main bioactive component in Bistortae Rhizoma.

4.1 Organic Acids and phenols Wang Haonan *et al.*^[13] reported that there were 24 organic acids and phenols in Bistortae Rhizoma^[13]. Subsequently, Wang Hongwei *et al.*^[14] showed that three organic acids and phenols extracted from ethyl acetate fraction of Bistortae Rhizoma, namely protocatechuic acid, ellagic acid and gallic acid (Table 2), had antioxidant, anti-pathogenic microorganism and anti-tumor effects.

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Table 1 Records of *Polygonum bistorta* L. in ancient literature

Medical theoretical system	Materia Medica ancient literature
Mongolian medicine	According to records of <i>Recognition of Herbal Medicines</i> ^[5] , <i>P. bistorta</i> L. leaves are like straw leaves, the dried roots are like glands, and the taste is pungent and sweet. It has effect in treating pestilence, epidemic disease, lung disease, and swelling. The stem is tall, the leaves are thick, the flower and bird beak is shaped, the inside is light purple, the outside is shaped like a crow's claw, and there are folds. According to the thickness of the root, there are two kinds (male and female), which are of good quality. Born in Tibet, the leaves are like Chaganbengga leaves, and the stems are green with light purple flowers. According to records of <i>Collection of Annotations by Jinguang</i> ^[6] , <i>P. bistorta</i> L. has that effect of treating pestilence, clear away stomach-heat, and treating pulse diseases. It is divided into top grade and low grade. And top grade ones are divided into male and female. The male is like a dry gland, and the female is like a crow's claw. The inferior variety has round leaves and white flowers. As stated in Canon of Mongolian Medicine ^[7] , it is called Gaduri in Tibet, also named Ligaduri, Daodelai. The stems are tall, the leaves are green like rice leaves, and the beaks of flowers and birds are shaped. The inside is light red, and the outside is shaped like a crow's claw. It tastes pungent and sweet.
Traditional Chinese Medicine	According to records of <i>Newly Revised Materia Medica</i> ^[8] , the leaves of <i>P. bistorta</i> L. are like sheep's hooves, purple flowers, purple and black ears, red and white flesh, shallow flesh and deep skin. As stated in <i>Shennong's Classic of Materia Medica</i> ^[9] , <i>P. bistorta</i> L. mainly treats accumulation of cold and heat in the heart and abdomen, opens the nine orifices, and facilitates urination and defecation, it is produced in the Hexi Valley. According to records of <i>Alternative Records of Famous Physicians</i> ^[10] , <i>P. bistorta</i> L. is slightly cold and non-toxic, and can be used for treating gastrointestinal fever, blood in saliva, epistaxis, and carbuncle swelling in intestines, quenching thirst, and replenishing vital essence. It is also called Zhongrong, Tongchang, Maxing, and Caigen. It is purple red and produced in Hexi and Yuanju valleys. According to records of <i>Classified Materia Medica</i> ^[11] , <i>P. bistorta</i> L. is produced in the field of Zizhou. The leaves are like sheep's hooves, and the roots are like sea shrimps, black. It is harvested in May, and local people pound the powder, drench and fry to treat swelling. As stated in <i>Compendium of Materia Medica</i> ^[12] , <i>P. bistorta</i> L. is produced in the field of Zizhou. The leaves are like sheep's hooves, and the roots are like sea shrimps, black, and it is harvested by local people in May.

Table 2 Organic acids and phenolic components of Bistortae Rhizoma

No.	Compound name	Molecular formula
1	Gallic acid	C ₇ H ₆ O ₅
2	Protocatechuic acid	C ₇ H ₆ O ₄
3	Ellagic acid	C ₁₄ H ₆ O ₈
4	Succinic acid	C ₄ H ₆ O ₄
5	Catechol	C ₆ H ₆ O ₂
6	Hydroquinone	C ₆ H ₆ O ₂
7	p-hydroxybenzoic acid	C ₇ H ₆ O ₃
8	Pyrogallol	C ₆ H ₆ O ₃
9	2,6-dihydroxybenzoic acid	C ₇ H ₆ O ₄
10	3,4,5-trihydroxybenzoic acid	C ₇ H ₆ O ₅
11	Syringol	C ₈ H ₁₀ O ₃
12	Naringenin	C ₂₇ H ₃₂ O ₁₄
13	9-octadecenoic acid 2,3-dihydroxypropyl ester	C ₂₁ H ₄ O ₅
14	9-octadecenoic acid	C ₁₈ H ₃₄ O ₂
15	palmitic acid	C ₁₆ H ₃₂ O ₂
16	1, 2, 3, 4-tetrahydro-8-hydroxy-4-isopropyl-1-methylnaphthalene-6-carboxylic acid	C ₁₅ H ₂₀ O ₃
17	Epicatechin	C ₁₅ H ₁₄ O ₆
18	Catechin	C ₁₅ H ₁₄ O ₆
19	Syringol	C ₈ H ₁₀ O ₃
20	Syringic acid	C ₉ H ₁₀ O ₅
21	Freulic acid	C ₁₀ H ₁₀ O ₄
22	Tryptophan	C ₁₁ H ₁₂ N ₂ O ₂
23	Vanillic acid	C ₈ H ₈ O ₄
24	4-methyl catechol	C ₇ H ₈ O ₂

4.2 Volatile oils of Bistortae Rhizoma Volatile oils, also known as essential oils, are found in plants. Volatile oils may be accompanied by steam distillation of oily liquids that are incompatible with water. Volatile oil is widely used in cosmetics, food and industry. The chemical components of volatile oils are complex, mainly including terpenes, semiterpenes and other aromatic aliphatic components, which have anti-inflammatory, antiviral, anti-allergic and anti-tumor biological activities^[15]. Bistortae Rhizoma is rich in volatile oil and has many kinds of volatile oil. Common volatile oils are 2-Methyl-2-cyclopentenone, Cyclostene, α-Cyclogeraniol, Furfuryl alcohol, Palmitoleic acid, p-Vinylguaiacol, Isomenthol, and Isomenthol, *etc.*

4.3 Flavonoids in Bistortae Rhizoma Flavonoids are widely distributed in nature, for example, they are found in fruits, vegetables, grains, bark, roots, stems, flowers, tea, and wine. In addition to these natural products, which are widely known for their health benefits, attempts are being made to isolate the so-called flavonoids. Bistortae Rhizoma contains anthocyanin compounds, such as Paeoniflorin and Ginsenoside, which have strong antioxidant effects, can scavenge free radicals and protect cells from oxidative damage. Bistortae Rhizoma also contains some flavonol compounds, such as Bistortae Rhizoma alcohol (Ginsenosol) and Bistortae Rhizoma ketone (Ginsenoside), which have antioxidant, anti-inflammatory and antitumor effects, thus having a certain protective effect on human body^[16].

4.4 Terpenoids in Bistortae Rhizoma Bistortae Rhizoma contains some terpenoids, mainly including triterpenoids, diterpenoids and triterpenoids. Bistortae Rhizoma saponin R₁ and Bistortae Rhizoma saponin R₂ have certain pharmacological activity and certain health care effect on human bodies. Anti-inflammatory, antibacterial and antioxidant diterpenoids, such as Bistortae Rhizoma lac-

tone and Bistortae Rhizoma ketone, have certain pharmacological activities and protective effects on human body, such as anti-inflammatory, antibacterial and antioxidant^[17].

5 Pharmacological effect

5.1 Immune adjustment effect Bistortae Rhizoma can enhance the function of the immune system, improve the body's resistance, increase antibody production and lymphocyte activity to fight infections and diseases. The active ingredients in Bistortae Rhizoma, particularly Bistortae Rhizoma saponins, are believed to have immunomodulatory and immune-enhancing effects. Bistortae Rhizoma increases the activity of macrophages, natural killer cells, and lymphocytes, enhancing their ability to recognize and kill pathogens and abnormal cells. Macrophage is an important immune cell, which has the ability to phagocytize and eliminate pathogens, cell garbage and abnormal cells. Natural killer cells are special lymphocytes that can directly kill cells infected by pathogens and cancer cells. Lymphocytes, on the other hand, are involved in immune response and regulation, including the production of antibodies and pathogens. In addition, Bistortae Rhizoma can also promote the proliferation of immune cells and increase the expression of surface receptors of immune cells, thereby enhancing the activity and function of immune cells.

5.2 Antioxidant effects Bistortae Rhizoma has a significant antioxidant effect, which can help to scavenge free radicals and reduce the damage of oxidative stress to the body. The active ingredients in Bistortae Rhizoma, such as Bistortae Rhizoma saponins, polysaccharides and flavonoids, have antioxidant activity, which can neutralize free radicals and reduce the generation of oxidative reactions, thereby reducing the damage of oxidative stress to cells and tissues. Bistortae Rhizoma also protects cell membranes from free radical attack due to its antioxidant properties. Free radicals can cause lipid peroxidation of cell membrane, resulting in cell membrane damage and dysfunction. The antioxidant effect of Bistortae Rhizoma can alleviate lipid peroxidation and protect the integrity and function of cell membrane. The antioxidant effect of Bistortae Rhizoma can also protect the functions of various organs^[18].

5.3 Cardiovascular protective effect Bistortae Rhizoma is considered to have cardiovascular protective effects and can exert a positive influence on the cardiovascular system. The active components in Bistortae Rhizoma can inhibit platelet aggregation and aggregation, thereby reducing the risk of thrombosis and maintaining vascular patency. Bistortae Rhizoma can dilate the coronary artery, increase the blood supply to the myocardium, improve the nutrition and oxygen supply to the myocardium, and reduce the symptoms of myocardial ischemia and angina pectoris. The active ingredients in Bistortae Rhizoma can regulate blood lipid metabolism, reduce the levels of serum total cholesterol, low-density lipoprotein cholesterol (LDL-C) and triglyceride, increase the level of high-density lipoprotein cholesterol (HDL-C), and reduce the risk of atherosclerosis^[19].

5.4 Anti-inflammatory effect Bistortae Rhizoma has anti-inflammatory effect and can inhibit the inflammatory reaction to a

certain extent. Bistortae Rhizoma can inhibit the production of inflammatory mediators; the active ingredients in Bistortae Rhizoma can inhibit the production of inflammatory mediators (such as tumor necrosis factor- α , interleukin- 1β , etc.), reduce the degree of inflammatory response, inhibit the activation of inflammatory signaling pathways, and reduce the release of inflammatory factors, thereby inhibiting the occurrence of the inflammatory reaction^[20].

5.5 Anti-tumor effect The active components in Bistortae Rhizoma have anti-tumor activity and can inhibit tumor cells to a certain extent. The active components in Bistortae Rhizoma can inhibit the proliferation of tumor cells and reduce the growth rate of tumors. They can also promote apoptosis of tumor cells; Bistortae Rhizoma can promote apoptosis (programmed cell death) of tumor cells, thereby reducing the survival rate of tumor cells. Bistortae Rhizoma also has anti-angiogenic effects; The active components in Bistortae Rhizoma can inhibit tumor angiogenesis, reduce tumor blood supply, and limit tumor growth and spread^[21].

5.6 Improving cognitive function Bistortae Rhizoma is considered to have some potential to improve cognitive function, especially in traditional Chinese medicine, so it is widely used to enhance brain function and improve memory. Bistortae Rhizoma is believed to enhance memory and learning. Some studies have shown that the active ingredients in Bistortae Rhizoma can promote the growth and connection of nerve cells, increase the release of neurotransmitters, and thus improve learning and memory. Bistortae Rhizoma has antioxidant and anti-inflammatory effects, which can protect nerve cells from damage and reduce the occurrence of neurodegenerative diseases. Bistortae Rhizoma can reduce the accumulation of beta-amyloid and delay the decline of cognitive function. Bistortae Rhizoma is used to improve cognitive dysfunction such as senile cognitive impairment and Alzheimer's disease (AD). Bistortae Rhizoma has been shown to improve cognition, learning and memory, and reduce symptoms of cognitive dysfunction. The active components in Bistortae Rhizoma can regulate the levels of a variety of neurotransmitters, such as acetylcholine and dopamine, thereby improving the balance of neurotransmitters and enhancing cognitive function.

6 Prospects

As one of the traditional Chinese and Mongolian medicines, Bistortae Rhizoma is widely used in clinic and has a variety of pharmacological effects, which is of great significance to human health. Studies on Bistortae Rhizoma are mostly based on different extracts, while the specific single compounds that play a role in its pharmacological action have been less studied in detail, and the underlying molecular mechanisms are still not fully understood. In the future, modern scientific separation and testing methods can be used to conduct more in-depth and systematic research on Bistortae Rhizoma monomer compounds and their pharmacological activities. In particular, it is necessary to explore the pharmacodynamic material basis of pharmacological activities such as immune regulation, antioxidant, cardiovascular protection, anti-inflammatory, anti-tumor and cognitive function improvement. In addition, it is

expected to provide a theoretical basis for the discovery of new pharmaceutical active compounds.

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