

The Chemical Constituents and Application Status of Radix Astragali

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Abstract. Radix Astragali, a highly renowned herbal medicine, boasts a venerable history within the realm of the traditional Chinese medicine. Its abundant therapeutic value has elicited widespread scholarly attention. This paper summarizes the chemical composition and pharmacological effects of the Radix Astragali and explores its application status in aquaculture and medical cosmetology. Radix Astragali is rich in chemicals. Flavonoids, saponins and astragalus polysaccharides are the main active components of Radix Astragali. These ingredients have many pharmacological effects, such as antioxidant, anti-inflammatory, antitumor, and immunomodulatory effects. In addition, Radix Astragali as a feed additive can improve the growth and development, and reproductive function and immune health of livestock and poultry. In the medical beauty industry, Radix Astragali has also been developed into a product with effects such as the sun protection and skin repair. These studies provide a basic basis for the research and application of astragalus and its active ingredients.

Keywords: Radix astragali; flavonoids; Saponins; Polysaccharides; Pharmacological action; Aquaculture; Medical cosmetology.

1. Introduction

Astragalus (*Astragalus* L.) is a perennial herb belonging to the legume family. It is a diverse genus with over 2000 species distributed across the globe. These species are classified into 11 subgenera. *Astragalus* can be found in various regions of the northern hemisphere, South America, and Africa. However, it is relatively rare in North America and Oceania. *Astragalus* is a light-loving plant that thrives in full sunlight. It is highly adaptable to drought conditions and possesses deep roots that enable it to access water and nutrients from the soil. *Astragalus* prefers to grow in sandy loam soils that are deep, fertile, and well-drained, allowing for optimal root development and efficient water drainage. Radix Astragali (root of *Astragalus*; Huangqi) is a very famous Chinese medicinal herb. Its main source is the roots of the legume *Astragalus* plant. *Astragalus* species commonly used to make Radix Astragali are *Astragalus membranaceus* and *A. membranaceus* var. *mongolicus*. Radix Astragali has a faint smell and a slight sweetness with a faint beany smell when chewed. It is cylindrical. Its length is generally between 30~90cm, and its diameter is between 1~3.5cm. The surface is pale brownish-yellow or pale tan, with irregular longitudinal wrinkles or longitudinal grooves. It is one of the most commonly used Chinese medicinal materials in clinical practice and has very high medicinal value. The author conducted research on Radix Astragali and summarized its key active ingredients and pharmacological effects, as well as its application in other aspects. This article aims to gain an in-depth understanding of the composition and application of *Astragalus* and lay a foundation for further exploring its potential medicinal value and other application values.

2. The chemical composition of Radix Astragali

At present, the main chemical components that have been isolated from *Astragalus mongholicus* and *Astragalus membranaceus* include flavonoids, saponins, polysaccharides, alkaloids, amino acids, trace elements and some other chemical components [1]. Some of these flavonoids and saponins are also used by Pharmacopoeia of the People's Republic of China to establish quality control standards.

2.1. flavonoids in Radix Astragali

Researchers isolated a variety of flavonoids from *Astragalus membranaceus* and *A. membranaceus* var. *mongolicus*. Among them, there are 9 species of Flavone, 20 species of Isoflavone, 10 species of Isoflavane, 8 species of Pterocarpan and 5 species of other Flavonoids [2].

2.2. Saponins in Radix Astragali

Astragalus saponins are the main active ingredient of *Radix Astragali*. The main components of *astragalus* saponins that have been found are *Astragalus* Saponins I. ~ VIII. Isoastragaloside I., II. And IV. Acetylastragalus Saponins, Cycloastragaloside E, F and G, Astragaloside IV. ~ IV. And Soybean Saponin I [3]. Among them, astragaloside IV is the main active ingredient of saponins. It is often used as a qualitative and quantitative index of *Radix Astragali*. The content of *astragalus* saponins in raw *Radix Astragali* ranged from 0.095% to 0.223% [4]. Studies have found that the plant variety containing the most *astragalus* saponins is *Astragalus membranaceus*, whose purity can reach more than 98%.

2.3. Polysaccharides in Radix Astragali

Radix Astragali contains many types of polysaccharides. It is mainly composed of monosaccharides such as Portuguese Glc, Gal, Ara, Rha, Man, GlcA and GalA. *Astragalus* polysaccharides are one of the rich ingredients in *Radix Astragali*. Its immune activity is the main source of *Radix Astragali* efficacy in immunity. The molecular weight distribution of *astragalus* polysaccharides ranges from 8.7×10^3 to 4.8×10^6 Da. In the structure of *astragalus* polysaccharides, the sugar ring signal is indicated as a pyranose ring, and there are two configurations: α and β [5]. The high-level structure of *astragalus* polysaccharides is diverse, showing different forms such as ribbon, e filament microfilament, roof-like small round ball, etc. In solution, *astragalus* polysaccharides may exist in the form of a single-stranded helix, and under certain conditions, a stranded helix conformation may be formed [6].

2.4. Other ingredients in Radix Astragali

At present, six alkaloid compounds such as *astragalus* A, B, C, D, E, F and so on have been successfully isolated and identified from *Astragalus membranaceus*. In addition, *Radix Astragali* is also rich in 25 amino acids such as γ -aminobutyric acid, threonine, asparagine, aspartic acid, serine, etc. *Radix Astragali* also contains more than ten trace elements such as zinc, iron, calcium, and manganese. Researchers also found more than 20 other substances such as amylase, vitamin D, carotene, folic acid and so on from *Radix Astragali*. Compared with *astragalus* saponins, polysaccharides and flavonoids, the above ingredients have lower content in *Radix Astragali* and are not the main active ingredients.

3. Pharmacological action of the active ingredient of Radix Astragali

Because *Radix Astragali* has a lot of pharmacological effects, it has been widely used in the field of traditional Chinese medicine since ancient times. After a long period of application, it has been found that its antioxidant, anti-inflammatory, immunomodulating, anti-tumor and anti-fatigue effects are excellent. These pharmacological effects are mainly attributed to the flavonoids, *astragalus* polysaccharides, saponins and other active ingredients in *Radix Astragali*.

3.1. Flavonoids

The flavonoids in *astragalus* have a variety of biological activities and pharmacological effects, exhibiting remarkable properties. They have excellent antioxidant power, neutralize free radicals and slow down the cellular aging process. Flavonoids such as anthonoids and isoflavones in *Radix Astragali* have a protective effect against cell damage. In addition, the flavonoids in *Radix Astragali* also exhibit anti-tumor activity, inhibit the proliferation of tumor cells such as leukemia and cervical

cancer, and exert excellent anti-tumor effects by regulating specific signaling pathways. They regulate the immune system, enhance the function of immune cells, and suppress the inflammatory response. In terms of the cardiovascular system, the flavonoids in astragalus can relax blood vessels, promote the proliferation of vascular endothelial cells, and have a positive and beneficial effect on the prevention and treatment of atherosclerosis. In addition, they exhibit anti-diabetic activity, lowering blood sugar levels, improving insulin resistance, and protecting the health of islet cells [7]. These biological activities and pharmacological effects make Radix Astragali a potential medicinal plant that can be used to improve and treat a wide range of diseases.

3.2. Saponins

The saponins in Radix Astragali exhibit a variety of beneficial effects, including anti-inflammatory, immunomodulating, antioxidant, anti-apoptosis, and metabolic regulation, and anti-fibrosis and tumor suppression. The researchers conducted a series of experiments to explore the effect of Astragaloside on qi deficiency model rats. Experimental results showed that Astragaloside can reduce creatine kinase (CK) activity, reduce lipid peroxide levels in the body, and regulate immune function, thereby playing the role of qi replenishment, delaying fatigue and enhancing exercise capacity [8]. Astragaloside A, also known as Astragaloside IV, is a key active ingredient in astragalus. The latest edition of the Chinese Pharmacopoeia identifies the content of Astragaloside A as one of the important indicators of Radix Astragali quality control. In recent years, researchers have conducted in-depth research on the pharmacological mechanism of action of Astragaloside A. The results showed that Astragaloside IV exhibited anti-inflammatory activity, which was able to enhance the vitality of chondrocytes, reduce the apoptosis rate, and have a repair effect on cartilage. In addition, Astragaloside A can significantly reduce neurological deficits in rats with cerebral ischemia-reperfusion injury, and reduce the degree of cerebral infarction and neuronal apoptosis.

3.3. Polysaccharides

Astragalus polysaccharides exhibit a variety of pharmacological effects, including immunomodulation, antitumor, antiatherosclerosis, hypoglycemia, antiviral, treatment of metabolic disorders, delay the progression of neurodegenerative diseases, and anti-aging [9]. The immunomodulatory effects of astragalus polysaccharides are considered to be one of the most important. Among them, MAPS-5, a component of astragalus polysaccharides, can stimulate T cell proliferation, but has a limited effect on B cells [10]. In addition, in macrophage activity tests, astragalus polysaccharides can significantly promote the production of cytokines such as GM-CSF, TNF- α and NO, while increasing NF- κ B protein levels. In addition to immunomodulatory effects, astragalus polysaccharides also have pharmacological activity to lower blood sugar. Studies have shown that astragalus polysaccharides can increase the expression of galactolin-1 in myocytes and increase the total mass of pancreatic β -cells [11]. This has a therapeutic effect on type I diabetes. In addition, Radix Astragali, rich in sugars or polysaccharides, also reduced symptoms such as insulin resistance and fatty liver disease in rats with type II diabetes. The hypoglycemic mechanism of astragalus polysaccharides is mainly related to its effect on skeletal muscle, which can reduce the expression of protein tyrosine phosphatase 1B, regulate the PKB/GLUT4 signaling pathway in skeletal muscle, and improve the body's sensitivity to insulin. In addition, astragalus polysaccharides also improve symptoms of early diabetic nephropathy by affecting the expression of NF- κ B and I κ B mRNA in the renal cortex [9].

4. Application of Radix Astragali in other fields

4.1. Aquaculture

The active ingredient of Radix Astragali has a variety of pharmacological effects. Its use as a feed additive can effectively improve the growth and development and health of livestock and poultry, thereby improving the economic benefits of livestock and poultry breeding and bringing advantages

to production efficiency. Therefore, astragalus has broad application prospects in the field of livestock and poultry breeding.

Radix Astragali is usually added to feed as a feed additive in the form of powder or extract. The specific method can vary according to different feed types and production needs.

As a feed additive, Radix Astragali has the characteristics of improving disease resistance and inflammation. Somatic cell count is an important indicator used to assess the degree of inflammation in dairy cows' udders. In general, milk with a low somatic cell index indicates good udder health. As a feed additive for dairy cows, Radix Astragali effectively alleviates the inflammation of breast epithelial cells by inhibiting the activity of pathogenic bacteria, reducing the number of somatic cells in milk [12]. Under the action of active ingredients such as astragalus polysaccharides, Radix Astragali can also enhance the function of the immune organs of animals and enhance their resistance. Radix Astragali feed additives help to improve the intestinal structure of livestock and poultry, inhibit intestinal inflammation, and improve the body's digestion and absorption of nutrients. Experiments have shown that compared with conventionally raised livestock and poultry, livestock and poultry based on Radix Astragali additives have richer muscle and crude fat content, better slaughtering performance and meat quality [13]. Radix Astragali can also promote the growth and development of animals, enhance their reproductive function and production performance. Studies have shown that feed with an appropriate amount of Radix Astragali can improve the bright color of poultry egg yolks and the thickness of eggshells [14]. When Radix Astragali is mixed with other herbs and added to ram feed as an additive, moderate addition can improve semen volume, sperm density, and motility in rams [15]. In addition, Radix Astragali can also increase milk production in dairy cows and has the effect of reducing cow stress response [13].

When using any addition, ensure that the amount of Radix Astragali is in accordance with the scientific ratio and recommended dosage to ensure its safety and efficacy. In addition, the proportioning, mixing operation and use method in the feed production process should comply with relevant regulations and technical standards to ensure that the addition of astragalus achieves the expected effect and synergizes with other feed ingredients. Rational use of these roles of Radix Astragali can contribute to the efficient, sustainable and healthy development of the livestock and poultry industry.

4.2. Medical cosmetology

As a Chinese herbal medicine, Radix Astragali has a wide range of application prospects in medical cosmetology due to its various active ingredients. Research and practice have proved that Radix Astragali can effectively protect the skin from ultraviolet rays and show good photoprotection, so it is used in the development of traditional Chinese medicine sunscreen. Compared to other sunscreens, Radix Astragali sunscreens are characterized by materials derived from natural plants, have a broad spectrum of anti-inflammatory benefits, and effectively and safely combat UV damage [16]. In addition, Radix Astragali also significantly exhibits anti-inflammatory and antibacterial properties, which can effectively inhibit the proliferation of bacteria such as *Propionibacterium* and *Staphylococcus aureus* produced in skin inflammation, thereby providing certain efficacy and improvement effects on acne and other skin inflammation problems [17]. The main active ingredient in Radix Astragali also has antioxidant properties, which can remove free radicals from the body and effectively delay the aging process of cells. In addition, Radix Astragali is widely used in the treatment of eczema and has the function of promoting skin repair and wound healing [16].

5. Conclusion

Radix Astragali is a very famous Chinese medicinal herb. Usually known as *Astragalus membranaceus* and *A. membranaceus* var. *made from the roots of mongolicus*. Radix Astragali contains a variety of chemical components, the main active ingredients of which include flavonoids, saponins, and astragalus polysaccharides. These ingredients confer a variety of pharmacological

effects on Radix Astragali such as antioxidant, anti-inflammatory, immunomodulating, antitumor, lowering blood pressure and protecting the cardiovascular system. Therefore, Radix Astragali has become a very famous Chinese medicinal herb and is widely used in the field of traditional Chinese medicine. In addition, Radix Astragali is used in other fields such as aquaculture and medical cosmetology. In the aquaculture industry, Radix Astragali feed additives can effectively improve the physical functions of livestock and poultry, thereby promoting the industrial development of the breeding industry. Radix Astragali is also used in medical cosmetology. Radix Astragali has good sun protection and antioxidant effects, can also improve skin inflammation, treat eczema and repair damaged skin. In medical cosmetology, Radix Astragali has excellent sun protection and antioxidant properties. At the same time, Radix Astragali can also improve skin inflammation and promote the repair of damaged skin. Radix Astragali is also used to treat skin problems such as eczema and acne.

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