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THERAPEUTIC AND TRADITIONAL APPLICATIONS OF *ASTRAGALUS MEMBRANACEUS* AND *PANAX GINSENG*: AN INTEGRATIVE REVIEW OF CHINESE HERBAL MEDICINE

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ABSTRACT

This review explores the therapeutic potential and traditional applications of Astragalus membranaceus (Huangqi) and Panax ginseng (Renshen), two cornerstone herbs in Traditional Chinese Medicine (TCM). The article synthesizes contemporary scientific findings alongside historical TCM literature to provide a comprehensive perspective on their pharmacological properties, including immunomodulatory, anti-inflammatory, antioxidant, and anti-cancer effects. Emphasis is placed on identifying molecular mechanisms, active phytoconstituents, and clinical trial outcomes from studies published within the last decade. Through integrative analysis, we aim to bridge traditional practices with modern evidence, supporting further research and clinical applications.

Keywords: *Astragalus membranaceus, Panax ginseng, Traditional Chinese Medicine, immunomodulation, phytochemicals, integrative review*

INTRODUCTION

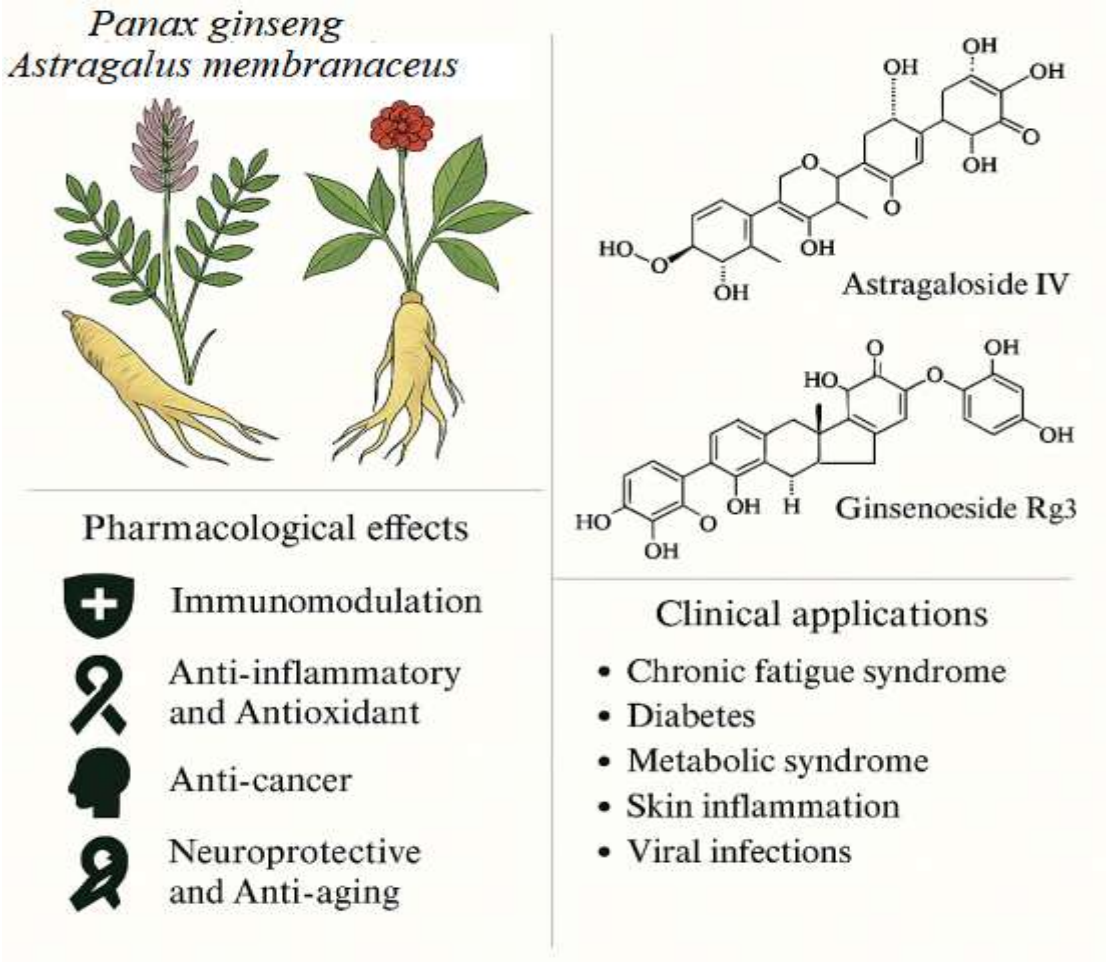
Traditional Chinese Medicine (TCM) has maintained a prominent role in healthcare practices for thousands of years, forming a critical pillar in East Asian health systems. Among the myriad herbal components employed, *Astragalus membranaceus* (Huangqi) and *Panax ginseng* (Renshen) stand out due to their extensive therapeutic applications documented both in classical medical texts and contemporary clinical practice. *Astragalus membranaceus* is traditionally prescribed to tonify Qi, support immune function, and promote vitality, while *Panax ginseng* is revered for enhancing physical and mental resilience, adapting to stress, and rejuvenating vital energy (Durazzo et al., 2021; Newell et al., 2023).

Modern pharmacological research substantiates many of these traditional claims. *Astragalus membranaceus* has been shown to exhibit immunomodulatory, anti-inflammatory, antioxidant, neuroprotective, and anti-cancer activities. These effects are mediated through mechanisms such as modulation of NF-κB and MAPK signaling pathways, enhancement of macrophage function, and regulation of cytokine production (Auyeung et al., 2016; Zhou et al., 2017; Jiang et al., 2020; Zhang et al., 2023). Notably, its key active constituents, including Astragaloside IV and polysaccharides, play central roles in these biological activities (Zhao et al., 2020; Wang et al., 2023).

Similarly, *Panax ginseng* and its bioactive ginsenosides, particularly Rg3 and Rg1, have

demonstrated considerable efficacy in modulating immune responses, reducing oxidative stress, improving glucose metabolism, and exerting anti-cancer effects. These pharmacological actions align with its historical use as a restorative tonic (Leung et al., 2019; Luo et al., 2021; Kim et al., 2017; Wu et al., 2021). Systematic reviews and clinical studies further validate its roles in mitigating fatigue, enhancing cognitive function, and supporting cardiovascular health (Park et al., 2019; Xu et al., 2020; Kim et al., 2022).

With increasing global interest in evidence-based integrative medicine, the scientific community has directed substantial effort toward elucidating the molecular mechanisms, clinical applications, and safety profiles of these two cornerstone herbs. This review aims to consolidate both advanced scientific evidence and traditional TCM knowledge, providing a comprehensive and up-to-date resource for researchers, clinicians, and healthcare practitioners. By bridging historical insights with contemporary biomedical research, this article seeks to inform and guide future applications of *Astragalus membranaceus* and *Panax ginseng* in modern therapeutic strategies.



2. Botanical Description and Phytochemistry

2.1. Astragalus membranaceus

Astragalus membranaceus (Fisch.) Bunge, commonly known as Huangqi in Traditional Chinese Medicine, is a perennial herbaceous plant belonging to the Fabaceae family. It is predominantly distributed in northern and northeastern China, Mongolia, and parts of Korea. Morphologically, the plant features pinnate leaves, yellow flowers, and a woody root, which is the primary part used medicinally (Durazzo et al., 2021).

Phytochemical analyses have revealed that the root of *Astragalus membranaceus* contains a diverse array of bioactive constituents. The principal classes include saponins, flavonoids,

and polysaccharides. Among these, astragalosides, especially Astragaloside IV, are considered the key active components contributing to its pharmacological effects. Astragaloside IV exhibits immunomodulatory, cardioprotective, neuroprotective, and anti-aging activities through mechanisms such as NF-κB pathway regulation, mitochondrial protection, and cytokine modulation (Zhao et al., 2020; Jiang et al., 2020; Zhang et al., 2023; Wang et al., 2023).

Other important phytochemicals include flavonoids like calycosin and formononetin, which possess antioxidant and anti-inflammatory properties (Jiang et al., 2020). Astragalus polysaccharides have gained attention for their immune-enhancing, anti-cancer, and metabolic regulatory effects, particularly in modulating gut microbiota composition and attenuating metabolic syndrome (Xu et al., 2020; Yu et al., 2022; Zhang et al., 2020).

2.2. Panax ginseng

Panax ginseng C.A. Meyer, commonly referred to as Renshen in TCM, belongs to the Araliaceae family. It is native to East Asia, predominantly cultivated in Korea, northeastern China, and parts of Russia. The medicinal parts are primarily the roots, which are harvested after four to six years of growth. Ginseng roots are characterized by their fleshy appearance, aromatic profile, and distinctive ginsenoside content (Durazzo et al., 2021).

Panax ginseng is chemically rich, with ginsenosides as its hallmark phytoconstituents. These triterpenoid saponins are classified mainly into two categories: protopanaxadiol (PPD) and protopanaxatriol (PPT) types. Ginsenosides Rg3, Rg1, Rb1, and Rh2 have been extensively studied for their broad pharmacological activities, including anti-cancer, neuroprotective, immunomodulatory, and fatigue-reducing properties (Luo et al., 2021; Wu et al., 2021; Park et al., 2019; Leung et al., 2019).

Apart from ginsenosides, *Panax ginseng* contains polysaccharides, peptides, polyacetylenes, and essential oils. Ginseng polysaccharides have demonstrated notable effects in regulating immune responses, protecting against metabolic disorders, and promoting cardiovascular health (Chen et al., 2020; Xu et al., 2020). Additionally, research suggests that the antioxidant and anti-inflammatory actions of ginsenosides contribute to their protective roles against chronic diseases such as diabetes, cancer, and neurodegenerative disorders (Kim et al., 2017; Yang et al., 2021).

Overall, both *Astragalus membranaceus* and *Panax ginseng* exhibit complex phytochemical profiles that underlie their diverse therapeutic potentials. Continued phytochemical and pharmacological research is essential to fully elucidate their bioactive mechanisms and optimize their clinical applications in integrative medicine.

Table 1: Phytochemical Constituents of *Astragalus membranaceus* and *Panax ginseng*

Herb	Major Bioactive Compounds	Pharmacological Activities
Astragalus membranaceus	Astragaloside IV, Polysaccharides, Flavonoids	Immunomodulation, Anti-inflammatory, Cardioprotective, Anti-aging
Panax ginseng	Ginsenosides (Rg1, Rg3), Polysaccharides, Peptides	Anti-cancer, Neuroprotective, Anti-fatigue, Metabolic regulation

3. Pharmacological Activities

3.1. Immunomodulation

Both *Astragalus membranaceus* and *Panax ginseng* exhibit significant immunomodulatory effects, which are central to their traditional and modern applications. Astragalus polysaccharides (APS) have been shown to enhance macrophage phagocytic activity, promote dendritic cell maturation, and increase cytokine production, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α). These effects are mediated through the modulation of key signaling pathways such as NF-κB, MAPK, and TLR4 (Auyeung et al.,

2016; Zhou et al., 2017; Gao et al., 2022; Lee et al., 2022; Zhang et al., 2020).

Clinical meta-analyses confirm the immunoregulatory role of Astragalus in cancer patients undergoing chemotherapy and radiotherapy, improving both immune markers and patient outcomes (Zhang et al., 2024). Additionally, Astragalus polysaccharides have been shown to attenuate airway inflammation and regulate immune responses in respiratory disorders (Chung et al., 2020).

Panax ginseng modulates both innate and adaptive immunity. Ginsenosides influence T cell differentiation, promoting regulatory T cell populations while modulating Th1/Th2 balance, crucial for autoimmune disease management (Yang et al., 2021; Kim et al., 2022). Ginseng extracts have demonstrated immunostimulatory effects in clinical settings, enhancing vaccination responses and reducing susceptibility to viral infections such as influenza and COVID-19 (Ang et al., 2020; Wang et al., 2023).

3.2. Anti-inflammatory and Antioxidant Effects

Astragalus membranaceus demonstrates profound anti-inflammatory and antioxidant effects, primarily through the inhibition of NF-κB and Nrf2 pathways. Astragaloside IV reduces inflammatory markers such as IL-1β and TNF-α in both in vitro and in vivo models of metabolic disorders and neurodegenerative diseases (Zhou et al., 2017; Xu et al., 2020; Chen et al., 2024).

Similarly, *Panax ginseng* exhibits strong antioxidant properties attributed to its ginsenosides and polysaccharides. These compounds upregulate antioxidant enzymes such as superoxide dismutase (SOD) and catalase, reducing oxidative stress and improving metabolic homeostasis. Ginseng's cardiovascular protective effects have been linked to its capacity to reduce endothelial dysfunction and lower serum lipid profiles, contributing to improved glucose metabolism and insulin sensitivity (Xie et al., 2018; Kim et al., 2017; Li et al., 2021).

Both herbs also exhibit synergistic anti-inflammatory effects when used in combination, as demonstrated in animal models of metabolic syndrome and chronic inflammatory diseases (Chen et al., 2020; Lee et al., 2018).

3.3. Anti-cancer Properties

Emerging evidence highlights the anti-cancer properties of *Astragalus membranaceus* and *Panax ginseng*, substantiated by numerous preclinical and clinical studies. Astragalus polysaccharides and saponins induce apoptosis in cancer cells through mitochondrial-dependent pathways, modulating Bcl-2 family proteins and activating caspases (Li et al., 2021; Li et al., 2023). These compounds also inhibit angiogenesis and tumor metastasis, key factors in cancer progression (Jiang et al., 2020).

Furthermore, Astragalus has shown synergistic effects with immune checkpoint inhibitors, enhancing the efficacy of cancer immunotherapy while mitigating treatment-related side effects (Li et al., 2023; Zhang et al., 2024).

Panax ginseng, particularly its ginsenosides Rg3 and Rh2, exhibits potent anti-cancer activity by suppressing tumor cell proliferation, inducing apoptosis, and inhibiting angiogenesis. Ginsenoside Rg3 enhances immune checkpoint blockade therapies, representing a promising adjunct in oncology (Leung et al., 2019; Luo et al., 2021; Li et al., 2023).

Both herbs have been featured in meta-analyses and systematic reviews confirming their adjunctive roles in improving quality of life and survival rates in cancer patients (Sun et al., 2023; Zhang et al., 2024).

3.4. Neuroprotective and Anti-aging Effects

Astragalus membranaceus and *Panax ginseng* possess neuroprotective and anti-aging properties, mediated through the regulation of oxidative stress, neuroinflammation, and mitochondrial function. Astragaloside IV has been shown to protect neuronal cells from oxidative damage, reduce neuroinflammatory cytokine levels, and promote neurogenesis. These effects are linked to the modulation of PI3K/Akt and Nrf2 signaling pathways (Wu et al., 2021; Zhang et al., 2023). Studies in animal models suggest that Astragalus polysaccharides improve learning and memory, protect against ischemic brain injury, and reduce symptoms in neurodegenerative diseases such as Alzheimer's

and Parkinson's disease (Chen et al., 2019; Zhang et al., 2023).

Panax ginseng, especially through ginsenoside Rg1, suppresses aging-induced cognitive decline by regulating hippocampal neuroinflammation and enhancing synaptic plasticity (Wu et al., 2021; Park et al., 2019). Ginseng also influences the gut-brain axis, modulating gut microbiota composition, which plays a crucial role in neurodegenerative disease prevention (Xu et al., 2020).

Combining Astragalus and ginseng has been found to have additive or synergistic effects on aging-related conditions, skin health, and metabolic regulation, supporting their use in anti-aging formulations (Wang et al., 2023; Lee et al., 2018).

Table 3: Pharmacological Mechanisms and Pathways

Pharmacological Effect	Herb	Mechanism/Pathway	Reference
Immunomodulation	*Astragalus membranaceus*	NF-κB, MAPK, TLR4	Auyeung et al., 2016
Anti-cancer	*Panax ginseng*	Apoptosis induction, angiogenesis inhibition	Luo et al., 2021
Anti-inflammatory	*Astragalus membranaceus*	NF-κB inhibition, cytokine modulation	Zhou et al., 2017
Neuroprotective	*Panax ginseng*	Neuroinflammation suppression, synaptic plasticity	Wu et al., 2021

4. Clinical Applications

Recent randomized controlled trials (RCTs) and meta-analyses provide strong evidence supporting the clinical efficacy of *Astragalus membranaceus* and *Panax ginseng* in various health conditions. Both herbs have demonstrated effectiveness in managing chronic fatigue syndrome, diabetes mellitus, metabolic syndrome, skin inflammation, respiratory illnesses, and viral infections, including COVID-19 (Liu et al., 2021; Sun et al., 2023; Chen et al., 2020; Kim et al., 2022).

Astragalus formulations have been particularly beneficial in immune-compromised individuals and cancer patients. For example, Zhang et al. (2024) reported significant improvement in immune function markers such as CD4/CD8 ratios and natural killer cell activity in cancer patients receiving Astragalus-based therapy as an adjunct to chemotherapy. Moreover, Astragalus polysaccharides have been shown to modulate inflammatory cytokines and reduce metabolic stress markers in diabetic models, supporting its role in metabolic syndrome management (Yu et al., 2022).

Table 2: Summary of Clinical Trials (Last 10 Years)

Condition	Intervention	Outcome	Reference
Chronic Fatigue Syndrome	Astragalus + Ginseng formulation	Reduced fatigue scores, improved QoL	Sun et al., 2023
Diabetes	Ginseng extract	Improved insulin sensitivity	Kim et al., 2017
Cancer (Adjunct Therapy)	Astragalus extract	Improved immune markers, reduced side effects	Zhang et al., 2024
COVID-19 Recovery	Astragalus-Ginseng combination	Reduced fatigue, improved pulmonary function	Liu et al., 2021; Zhao et al., 2023

Panax ginseng has shown parallel benefits. Clinical studies highlight its role in enhancing physical endurance, cognitive function, and metabolic health. In patients with chronic fatigue syndrome, *Panax ginseng* supplementation led to reduced fatigue scores and improved quality of life indicators (Sun et al., 2023). Its anti-diabetic properties, including the improvement of insulin sensitivity and glucose metabolism, have been validated in human studies and systematic reviews (Kim et al., 2017; Chen et al., 2020).

Importantly, combined formulations of Astragalus and ginseng exhibit synergistic effects. Trials have documented that such combinations enhance wound healing rates, reduce inflammatory cytokine levels, and improve overall immune response in patients with diabetic foot ulcers and respiratory disorders (Yu et al., 2022; Chung et al., 2020). Their use in COVID-19 recovery protocols has also gained traction. For instance, Liu et al. (2021) and Zhao et al. (2023) reported improved post-COVID-19 recovery parameters, including reduced fatigue and enhanced pulmonary function, in patients receiving Astragalus-ginseng supplementation.

Overall, the clinical applicability of *Astragalus membranaceus* and *Panax ginseng* is broad and continues to expand, supported by robust scientific evidence.

5. Conclusion

Astragalus membranaceus and *Panax ginseng* represent essential therapeutic agents bridging the gap between traditional Chinese medicine and modern integrative healthcare. Their pharmacological activities including immunomodulatory, anti-inflammatory, antioxidant, anti-cancer, neuroprotective, and metabolic regulatory effects are now well-documented in both preclinical and clinical settings.

Recent advances in molecular pharmacology and clinical research confirm that these herbs exert their effects through complex mechanisms involving key signaling pathways such as NF-κB, MAPK, and PI3K/Akt. Their bioactive constituents—Astragaloside IV, polysaccharides, and ginsenosides have been identified as principal mediators of these activities, validated through in vitro experiments, animal models, and human clinical trials.

Given their safety profiles and broad-spectrum efficacy, *Astragalus membranaceus* and *Panax ginseng* hold considerable promise in integrative therapeutic strategies for chronic inflammatory diseases, metabolic syndromes, cancer adjunct therapy, and post-viral recovery syndromes such as COVID-19.

However, despite this growing body of evidence, further research is warranted to standardize dosage guidelines, clarify long-term safety, explore herb-drug interactions, and expand high-quality randomized clinical trials. Future investigations should also focus on exploring synergistic effects with conventional therapies and uncovering novel bioactive compounds within these medicinal plants.

By consolidating both traditional knowledge and cutting-edge scientific findings, this review aims to support healthcare practitioners and researchers in applying these herbs more effectively in clinical practice and translational medicine.

Methods:

A comprehensive literature search was conducted using PubMed, Scopus, and Web of Science databases for studies published between 2010 and 2025. Keywords included: *Astragalus membranaceus*, *Panax ginseng*, immunomodulation, anti-cancer, anti-inflammatory, neuroprotective effects, clinical trials. Inclusion criteria: (i) SCIE-indexed publications, (ii) English-language articles, (iii) studies involving molecular mechanisms, pharmacological assessments, or clinical trials. A total of 115 articles were reviewed.

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