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REVIEW

Traditional Chinese Medicine for Allergic Rhinitis: Mechanisms, Evidence, and Gut-Immune Axis Targets

Shuang Liu[1], Yu Zhang[2], Jian Lv[3], Ling Zhou[4]

[1]First Clinical Medical College, Heilongjiang University of Chinese Medicine, Harbin, Heilongjiang, People's Republic of China; [2]Second Clinical Medical College, Heilongjiang University of Chinese Medicine, Harbin, Heilongjiang, People's Republic of China; [3]Graduate School, Heilongjiang University of Chinese Medicine, Harbin, Heilongjiang, People's Republic of China; [4]Otolaryngology Department, The First Hospital Affiliated, Heilongjiang University of Chinese Medicine, Harbin, Heilongjiang, People's Republic of China

Correspondence: Ling Zhou; Jian Lv, Email zhouling8913@163.com; Lv914010978@163.com

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Objective: Allergic rhinitis (AR) is a highly prevalent allergic disorder with increasing global incidence, and gut microbiota dysbiosis has emerged as a key pathogenic factor. This review systematically synthesizes evidence on how traditional Chinese medicine (TCM)—including single herbs, herbal formulas, and auxiliary therapies—alleviates AR by targeting gut microbiota, aiming to clarify mechanistic pathways and provide evidence-based support for clinical practice.

Methods: A comprehensive literature search was conducted in PubMed, China National Knowledge Infrastructure (CNKI), and Embase databases. Keywords included ["Traditional Chinese Medicine" or "TCM" or "Chinese herbal medicine" or "herbal formula"], ["allergic rhinitis" or "AR"], ["gut microbiota" or "intestinal microbiota"], ["immune regulation"], ["intestinal barrier"], and ["inflammatory mediator"]. Only peer-reviewed studies (human or animal models) focusing on TCM-gut microbiota-AR interactions were included; non-relevant, non-peer-reviewed, or duplicate articles were excluded.

Results: A total of 210 relevant studies were initially identified from the three databases (PubMed: 67, Embase: 55, CNKI: 88); subsequently, 122 duplicate records, 44 irrelevant records (38 with title mismatch, 6 including meetings, case reports, and protocols), and 22 low-quality studies were excluded, and finally 24 studies were included in this review. TCM exerts anti-AR effects through multi-targeted modulation of the gut microbiota-intestinal barrier-immune axis. TCM (eg, Astragalus membranaceus, Xiaoqinglong Decoction) increases the abundance of beneficial bacteria (eg, Lactobacillus, Bifidobacterium) and reduces pathogenic taxa, while promoting the production of microbial metabolites like short-chain fatty acids (SCFAs). TCM components upregulate tight junction proteins (ZO-1, Occludin) and activate the PI3K/Akt pathway to enhance intestinal epithelial integrity, reducing barrier permeability. TCM balances Th1/Th2/Treg cell subsets, inhibits NLRP3 inflammasome-mediated pyroptosis, and reduces pro-inflammatory mediators (IL-4, IL-5, TNF-α) while elevating anti-inflammatory cytokines (IL-10, IFN-γ). Clinical trials confirm TCM alleviates AR symptoms (nasal congestion, rhinorrhea), lowers serum IgE levels, and reduces disease recurrence.

Conclusion: TCM ameliorates AR by integrating gut microbiota modulation, intestinal barrier repair, and immune regulation—highlighting its multi-pathway, multi-target advantages. Current limitations include insufficient large-scale randomized controlled trials and unclear TCM-microbiota crosstalk at the molecular level. Future research should leverage multi-omics technologies to decipher precise mechanisms and explore TCM-Western medicine combinations for optimized AR management.

Keywords: traditional Chinese medicine, allergic rhinitis, gut microbiota, intestinal barrier, immune regulation, inflammatory mediator

Introduction

Allergic rhinitis (AR) is a common allergic disorder with a globally increasing incidence, particularly prevalent among children and adolescents.[1] According to statistics from the World Health Organization, the incidence of AR can be as high as 40% in certain regions.[2] AR not only impairs patients' quality of life but also may lead to other complications, such as asthma and other respiratory diseases.[3] The etiology of AR is complex, involving multiple factors including genetics, environment, and immune responses. Among these, dysbiosis of the gut microbiota is considered one of its pathogenic mechanisms.[4,5]

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The gut microbiota, composed of trillions of microorganisms, is involved in immune regulation and metabolic processes of the host.[6] Studies have demonstrated that the composition of the gut microbiota is closely associated with the host's immune function, and the diversity and abundance of gut microorganisms are crucial for immune system health.[6–8] In patients with AR, gut microbial dysbiosis may induce abnormal immune responses, thereby exacerbating allergic symptoms.[9] Therefore, regulating the gut microbiota has emerged as one of the novel strategies for AR treatment.[10]

Current clinical guidelines for AR recommend intranasal corticosteroids and oral/nasal antihistamines as first-line therapies, focusing on rapid symptom relief.[11] However, the position of traditional Chinese medicine (TCM) in these guidelines remains unclear: it is not recognized as a first-line alternative but is increasingly regarded as a complementary therapy for refractory AR—particularly suitable for patients with inadequate responses to conventional drugs or those seeking to reduce long-term medicine dependency. TCM, as a conventional therapeutic approach, possesses unique advantages in regulating the gut microbiota and improving immune function.[12,13] Guided by the holistic concept in TCM theory, the health status of the human body is considered closely associated with the gut microbiota.[14] By regulating the gut microbiota, immune function can be improved, thereby effectively alleviating the symptoms of AR.[3,15] In recent years, a growing number of studies have focused on the application of TCM in AR treatment, particularly its role in regulating the gut microbiota, which has demonstrated favorable clinical efficacy and safety.[16]

This review systematically synthesizes peer-reviewed evidence on TCM's (single herbs, formulas, auxiliary therapies) regulation of the "gut microbiota-intestinal barrier-immune axis" in AR, clarifies key mechanisms, and provides evidence-based support for TCM's positioning as an alternative/adjunctive therapy.

Methods

Search Strategy

To identify published studies, we conducted a comprehensive search of PubMed, China National Knowledge Infrastructure (CNKI), and Embase databases, covering records from January 2010 to July 2025. Our search approach comprises the following sets of keywords: ["Traditional Chinese Medicine" or "TCM" or "Chinese herbal medicine" or "herbal formula"], ["allergic rhinitis" or "AR"], ["gut microbiota" or "intestinal microbiota"], ["immune regulation"], ["intestinal barrier"], and ["inflammatory mediator"]. Only peer-reviewed studies (human or animal models) focusing on TCM-gut microbiota-AR interactions were included; non-relevant, non-peer-reviewed, or duplicate articles were excluded.

Data Extraction and Synthesis

Before reviewing the complete content of any paper, we manually select references related to the topic using Excel. Finally, all included materials are peer reviewed articles related to the topic. When drafting the paper, one author is responsible for extracting data. Afterwards, other authors cross validated the extracted data to ensure its integrity and reliability. A total of 210 relevant studies were initially identified from the three databases (PubMed: 67, Embase: 55, CNKI: 88); subsequently, 122 duplicate records, 44 irrelevant records (38 with title mismatch, 6 including meetings, case reports, and protocols), and 22 low-quality studies were excluded, and finally 24 studies were included in this review. Only peer-reviewed studies focusing on TCM-gut-immune axis-AR interactions were included during the screening process. See Figure 1 for details.

The Pathogenesis of Allergic Rhinitis

The Interaction Between Environmental Factors and Genetic Factors

The pathogenesis of AR is complex, involving the interaction between environmental and genetic factors (as shown in Figure 2). Environmental factors such as air pollution, pollen, and dust mites have been confirmed to significantly influence the occurrence and progression of AR.[17–19] Studies have demonstrated that early exposure to these allergens may induce abnormal immune responses to harmless substances, thereby triggering allergic reactions.[12,20] Additionally, genetic factors also play a crucial role in the pathogenesis of AR.[21] Individuals with a family history of allergic diseases have a significantly increased risk of developing AR, suggesting that genetic susceptibility serves as a key factor in the onset of this disease.[4,20] Therefore, the interaction between environmental and genetic factors is one of the important mechanisms underlying the pathogenesis of AR.

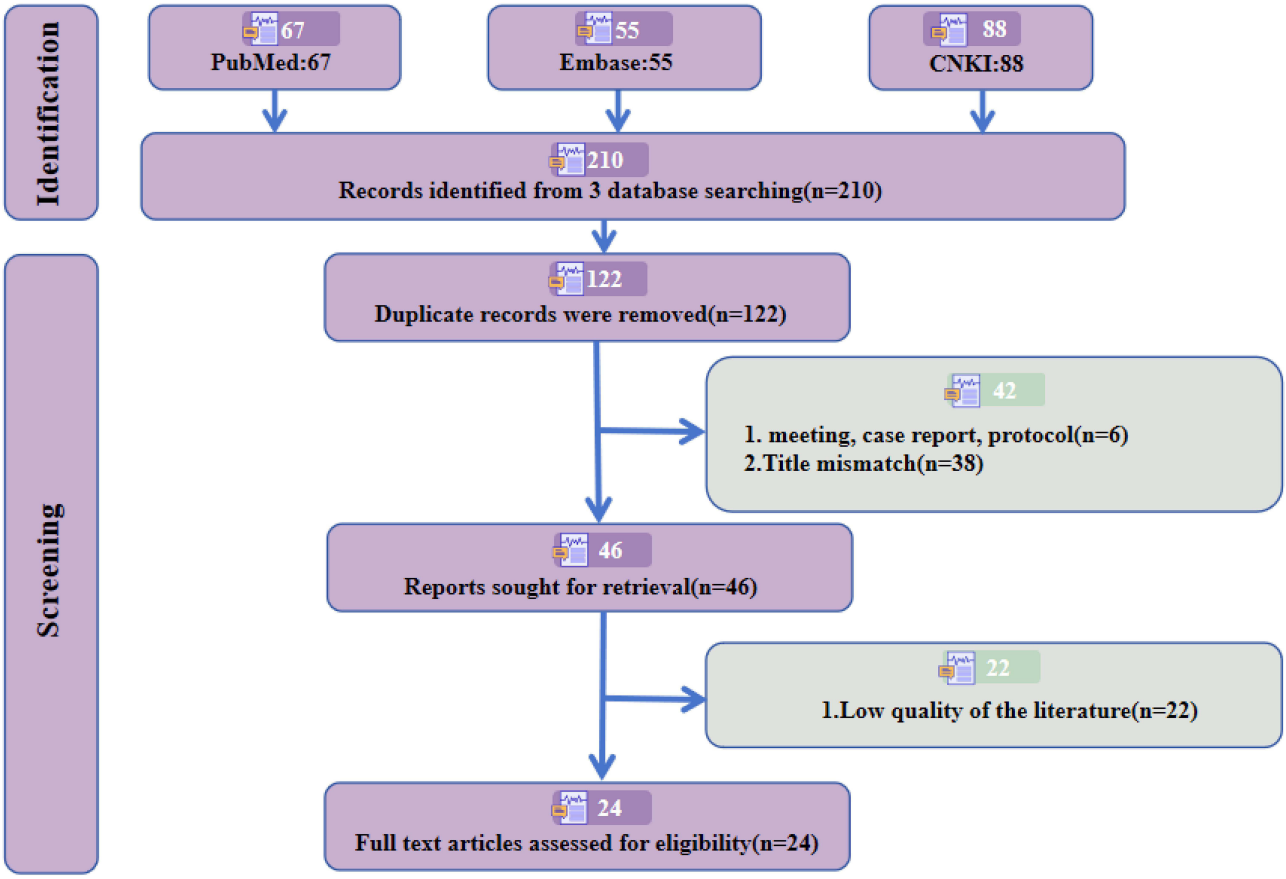

Figure 1 Literature Screening Flowchart.

Abnormal Reactions of the Immune System

The core mechanism of AR lies in abnormal immune responses. In patients with AR, specific immune cells (eg, T cells and B cells) exhibit abnormal responses to allergens, leading to the excessive production of immunoglobulin E (IgE) antibodies.[16,22] This IgE-mediated immune response triggers a cascade of inflammatory reactions, prompting mast cells and eosinophils in the nasal cavity to release large amounts of inflammatory mediators (such as histamine and leukotrienes).[23] These mediators induce typical symptoms including nasal congestion, rhinorrhea, and sneezing.[3,24] Abnormal activation of T cells—particularly the overreaction of Th2 cells—also plays a pivotal role in the pathogenesis of AR.[25] Additionally, immune system dysregulation may be associated with gut microbiota dysbiosis; studies have revealed that changes in the gut microbiota can affect systemic immune responses, thereby influencing the development of AR.[26]

Excessive Release of Inflammatory Mediators

In the pathogenesis of AR, the excessive release of inflammatory mediators is one of the primary causes of symptom exacerbation.[27] Re-exposure to allergens triggers the activation of immune cells, leading to the massive release of inflammatory mediators such as histamine and interleukins (eg, IL-4, IL-5, IL-13).[28,29] These inflammatory mediators not only directly induce nasal inflammatory responses but also increase the permeability of local blood vessels, resulting in nasal mucosal edema and increased secretions—thereby exacerbating symptoms such as nasal congestion and rhinorrhea.[26,30] Therefore, controlling the release of inflammatory mediators is one of the important strategies for AR treatment, and researchers are exploring the regulation of these mediators' release via TCM to achieve symptom relief.[31]

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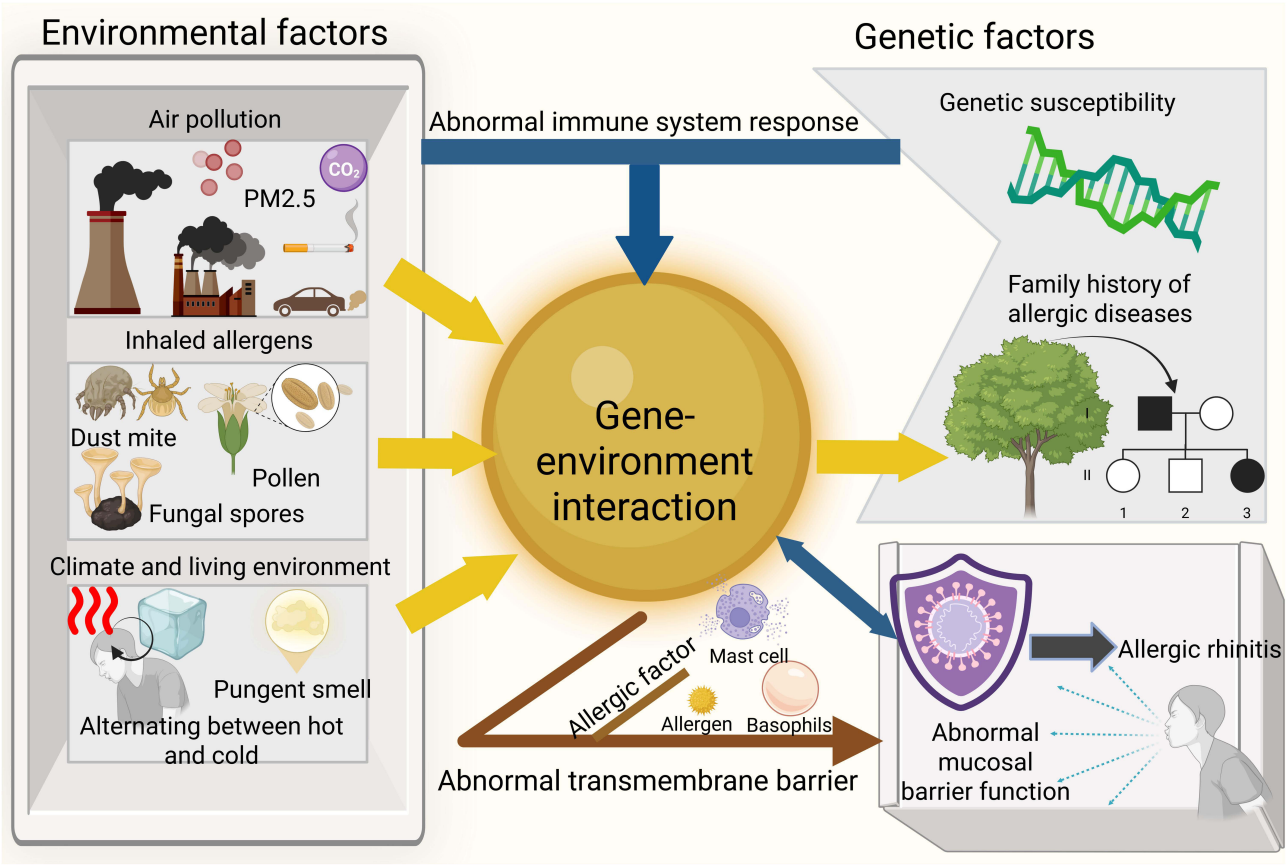

Figure 2 The pathogenesis of allergic rhinitis.

Imbalance of Gut Microbiota

The normal gut microbiota constitutes a complex microbial ecosystem, primarily composed of diverse microorganisms including bacteria, fungi, viruses, and protozoa.[32] Studies have demonstrated that the gut of a healthy adult harbors approximately 100 trillion microorganisms, encompassing over 1000 distinct bacterial species, with the phyla Firmicutes and Bacteroidetes being dominant.[26] These microorganisms play crucial roles in the host's nutrient metabolism, immune regulation, and intestinal barrier protection.[33] The normal gut microbiota can promote the health of intestinal epithelial cells and enhance intestinal barrier function by producing metabolites such as short-chain fatty acids (SCFAs), thereby preventing pathogen invasion.[4,34]

Gut microbiota dysbiosis refers to abnormal changes in the composition and function of the intestinal microbial community, typically characterized by a reduction in beneficial bacteria and an increase in harmful bacteria. This dysbiosis is closely associated with the development of various diseases, including AR, inflammatory bowel disease (IBD), obesity, and diabetes.[16] Studies have revealed that gut microbiota dysbiosis may impair intestinal barrier function and increase intestinal permeability, thereby triggering systemic inflammatory responses.[6,35] For instance, in patients with AR, the diversity and abundance of gut microbiota are often significantly reduced, which is associated with abnormal immune responses in these patients.[36] Additionally, gut microbiota dysbiosis may further exacerbate the severity of allergic symptoms and other related diseases by influencing the neuroendocrine system and metabolic pathways.[3,33] Therefore, restoring gut microbiota balance is considered one of the important strategies for the prevention and treatment of AR.[28]

The Relationship Between the Basic Theory of TCM and Allergic Rhinitis

TCM understands AR based on its unique theoretical system, emphasizing the invasion of the human body by external pathogenic factors such as "wind" ("feng"), "cold" ("han"), and "dampness" ("shi"), as well as the dysfunction of zang-fu organs including the "spleen" ("pi") and "lung" ("fei").[37] TCM holds that the onset of AR is closely associated with the interaction between an individual's constitution, environmental factors, and pathogenic factors.[38] In accordance with TCM's principle of "syndrome differentiation and treatment" ("bian zheng lun zhi"), AR can be classified into multiple types, such as wind-heat type ("feng re xing"), wind-cold type ("feng han xing"), and spleen-deficiency type ("pi xu xing").[39] Each type presents distinct symptoms and requires different treatment approaches. For instance, patients with the wind-heat type often exhibit symptoms including rhinorrhea, nasal congestion, and sneezing; in their treatment, TCM herbs with heat-clearing and toxin-resolving effects (eg, Chrysanthemum morifolium Ramat. and Mentha haplocalyx Briq.) can be used.[40] Additionally, TCM emphasizes preventing and treating AR by regulating zang-fu organ function and enhancing the body's immune resistance, holding that restoring the balance of "yin" and "yang" within the body is the key to treatment.[9]

TCM is widely applied in the treatment of AR, mainly including Chinese herbal medicines (CHMs), acupuncture, and other adjuvant therapies. Studies have demonstrated that TCM herbal formulas such as Xiaoqinglong Decoction and Yupingfeng Powder exhibit significant efficacy in alleviating AR symptoms. Xiaoqinglong Decoction not only reduces rhinitis symptoms but also regulates the gut microbiota and improves the body's immune response, thereby enhancing therapeutic effectiveness.[9] In addition, as a conventional TCM therapeutic approach, acupuncture can effectively alleviate symptoms in AR patients by stimulating specific acupoints, and its efficacy has been verified in clinical studies.[30] Furthermore, recent studies have shown that comprehensive treatment regimens integrating TCM can effectively reduce the recurrence rate of AR and improve patients' quality of life.[27] Systematic research on the application of TCM in AR can provide more individualized and precise regimens for clinical treatment.

Application of TCM in Regulating Intestinal Microbiota for the Treatment of Allergic Rhinitis

Application of Chinese Herbal Medicine and Its Active Ingredients in Regulating Intestinal Microbiota for the Treatment of Allergic Rhinitis

CHMs and their bioactive components have demonstrated significant potential in regulating the gut microbiota, particularly in the treatment of AR (as shown in Table 1). Studies have indicated that certain CHM components can modulate the composition and function of the gut microbiota, thereby influencing the body's immune responses.[41] In the TCM-based treatment of AR, commonly used CHMs include *Xanthium sibiricum* Patrin ex Widder (Siberian cocklebur fruit, Asteraceae; official drug name: Cang'erzi), *Angelica dahurica* (Fisch. ex Hoffm). Benth. et Hook. f. (Taiwan angelica root, Apiaceae; official drug name: Baizhi), and *Magnolia denudata* Desr. (Yulan magnolia flower, Magnoliaceae; official drug name: Xinyi).[42,43] These herbs possess the effects of dispelling wind and cold, and unblocking nasal orifices to relieve pain, which can effectively alleviate symptoms such as nasal congestion and rhinorrhea. Some CHMs, such as *Astragalus membranaceus* (Fisch). Bunge (Milkvetch root, Fabaceae; official drug name: Huangqi) and *Codonopsis pilosula* (Franch). Nannf. (Pilose asiabell root, Campanulaceae; official drug name: Dangshen), also exhibit anti-allergic properties and immunomodulatory functions.[44,45] They can reduce the level of specific IgE and the infiltration of inflammatory cells, thereby mitigating nasal allergic reactions in AR.

In a 6-week, double-blind, placebo-controlled clinical trial, *Astragalus membranaceus* (Fisch). Bunge (Milkvetch root, Fabaceae; official drug name: Huangqi) was found to significantly improve key outcome measures, including reflective symptom scores and quality of life.[57] It also reduced nasal eosinophil counts and serum IgE levels, while alleviating clinical symptoms in patients with seasonal allergic rhinitis.[57] *Glycyrrhiza uralensis* Fisch. [Leguminosae, *Glycyrrhiza uralensis* Fisch. ex DC. (Licorice root, Fabaceae; official drug name: Gancao)] is frequently used as a harmonizing ingredient in various TCM formulations.[59] A study has shown that *Glycyrrhiza uralensis* Fisch. can inhibit the expression of IL-4, IL-5, and IL-13, thereby reducing goblet cell hyperplasia and excessive mucus secretion in the lungs and airways of asthmatic mice.[60] Traditional Chinese medicines such as *Astragalus membranaceus* Fisch. Bunge and *Atractylodes macrocephala* Koidz.

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Table 1 The Application of Chinese Herbal Medicines and Their Active Components in Regulating the Intestinal Microbiota for the Treatment of AR

TCM	Parts/ Components	Main Active Components	Model	Gut Microbiota Changes	Related Mechanism	Clinical Manifestation	Results	References
Gleditsia sinensis Lam	Leguminosae family, Gleditsia	Neochlorogenic acid, Syringin, Chlorogenic acid, Orientin, Eleutheroside E, Hesperidin, Liquiritigenin	An AR mouse model induced by OVA	——	The extract of Saponaria officinalis reduces the production of MUC5AC mucin by inhibiting the STAT3/STAT6 signaling pathway, thereby alleviating the nasal inflammation in allergic rhinitis.	The nasal allergy symptoms were relieved, the specific IgE level decreased, and the IL-13 level significantly dropped, Reduced thickness of the nasal mucosa.	GSAE treatment inhibits the production of MUC5AC in primary human nasal epithelial cells stimulated by IL-4/IL-13 through the STAT3/STAT6 signaling pathway, thereby exerting therapeutic effects on AR.	Jung, 2023[46]
Ephedra sinica	Ephedraceae, Ephedra, Dry herbaceous stems	Ephedra sinica polysaccharide	The AR rat model induced by OVA	——	ESP-B4 promotes the secretion of miR-146a-5p, affects the Th1/Th2 balance of helper T cells, and alleviates AR symptoms through Smad3/ GATA-3 interaction.	The level of Th1-type cytokine IFN-γ increased, the level of Th2-type cytokine IL-4 decreased, the ratio of IFN-γ/IL-4 returned to normal, the nasal mucosa underwent pathological repair, and within 10 minutes after the last stimulation, the total scores of sneezing frequency, nasal scratching degree, and runny nose volume in rats significantly decreased.	ESP-B4 is the key active component in ephedra that treats allergic rhinitis. It regulates immune balance through the miR-146a-5p/ Smad3/GATA-3 pathway.	Li, 2023[47]
Honeysuckle	Caprifoliaceae, Lonicera, Dried flower buds or those in the early stage of blooming	Water-extracted Lonicera japonica polysaccharide	An AR mouse model induced by OVA	Paenibacillus↓, Longispora↓, Dechloromonas↑, Brachybacterium↑	Inhibit the activation of the NLRP3 inflammasome, Reduce the differentiation of Th17 cells in the spleen and lower the serum level of IL-17,Inhibit the release of TNF-α and IL-1β induced by LPS + IFN-γ	Sneezing and nasal rubbing frequency significantly decreased, serum IgE levels significantly dropped, the degree of nasal mucosa epithelial thickening was alleviated, and high-dose WLJP significantly reduced the number of goblet cells.	The WLJP improves allergic rhinitis by repairing the damaged intestinal barrier, inhibiting the inflammatory response driven by the NLRP3 inflammasome, and modulating the Th17 immune response.	Bai, 2022[48]

Saposhnikovia divaricata`	Apiaceae, Saposhnikovia, Dried root	Polysaccharides, 5-O-methylvisamminol glycoside	An AR mouse model induced by OVA	——	Inhibit the TLR4/TRAF6/NF-κB signaling pathway, inhibit the IL-6/ROR-γt/STAT3 signaling pathway, and reduce the levels of pro-inflammatory/allergic mediators in serum and NLF.	After the treatment with Saposhnikovia divaricata, the frequency of sneezing and rubbing the nose was significantly reduced within 15 minutes, and the behavioral symptoms were obviously relieved. The disorder and swelling of the nasal mucosa cell arrangement were alleviated, and the number of goblet cells and mast cells was significantly decreased.	Saposhnikovia divaricata can effectively alleviate the symptoms and pathological damage of allergic rhinitis in mice through a dual mechanism of "regulating inflammatory pathways + improving the intestinal microbiota".	Chen, 2022[49]
Fructus Amomi Cardamomi	Zingiberaceae, Amomum, Amomum villosum Lour	Essential oil	An AR mouse model induced by OVA, and experiments related to rat peritoneal mast cells were conducted simultaneously using rats.	——	Regulate the Th1/Th2 balance, inhibit the phosphorylation of NF-κB, and suppress the degranulation and histamine release of mast cells	After treatment with saussurea, the number of nose rubbing and sneezing in the mice decreased significantly within 20 minutes. The nasal allergic symptoms were significantly improved, and the inflammation in the nasal cavity and lung tissues was alleviated.	The sandalwood extract demonstrated a significant anti-allergic effect in the OVA-induced allergic rhinitis mouse model, and is expected to become an effective candidate drug for the treatment of allergic rhinitis.	Fan, 2022[50]
Scutellaria baicalensis Georgi	Lamiaceae, Scutellaria, Dry roots	Baicalin	The AR rat model induced by OVA	——	Regulating the balance between regulatory Treg and helper Th17. Inhibit the levels of histamine and IgE in the serum	The frequency of sneezing significantly decreased, the frequency of nose scratching in mice decreased markedly, the degree of damage to the nasal sinus mucosa significantly reduced, the epithelial damage decreased, and the number of white blood cell infiltration decreased.	Wogonin effectively alleviates nasal sinus inflammation in mice by restoring the Treg/Th17 immune balance.	Yang, 2022[51]

(*Continued*)

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Table 1 (Continued).

TCM	Parts/ Components	Main Active Components	Model	Gut Microbiota Changes	Related Mechanism	Clinical Manifestation	Results	References
Dendrobium nobile	Orchidaceae, Dendrobium, Stem Bast Fibers	Dendrophenol, Polysaccharide	Ovalbumin OVA-induced AR) mouse model	Bacteroidota↓, Proteobacteria↓, Firmicutes↑	Inhibit the PI3K/AKT/ mTOR inflammatory pathway, Promote the differentiation of regulatory Treg, Regulating the balance of cytokines	The nasal allergy symptoms were alleviated, the inflammation of the nasal mucosa was reduced, the upper respiratory tract - lower respiratory tract interrelated inflammation was improved, and the serum levels of OVA-sIgE in the model mice were significantly decreased. OVA-sIgE is a key marker of allergic reactions in AR, and its level decline indicates a weakened allergic reaction.	Epimedium can effectively alleviate egg white-induced allergic rhinitis by regulating the intestinal flora and inhibiting pulmonary inflammation.	Duan, 2022[52]
Astragalus membranaceus	Fabaceae, Astragalus, Root	Astragalus Polysaccharides	An OVA-induced AR rat model	——	Inhibit the activation of NLRP3 inflammasome. Inhibit NOD2-mediated NF-κB activation. Regulate Th2-related cytokines	After treatment with astragalus polysaccharides, the number of sneezes and nasal friction in rats significantly decreased, and the levels of OVA-sIgE and histamine in serum significantly decreased. The allergic symptoms in the nasal cavity were significantly alleviated.	Astragalus polysaccharides can effectively alleviate the inflammatory symptoms of allergic rhinitis in rats induced by OVA.Its mechanism of action is related to the inhibition of NLRP3 inflammasome activation and the activation of NF-κB mediated by NOD2.	Xu, 2021[53]
Red Ginseng	Araliaceae, Panax, Steamed root	Ginsenoside Rd	The study employed an OVA -induced AR model in BALB/ c mice.	Firmicutes↑, Bacteroidetes↓, Actinobacteria↓	Inhibiting the expression of allergy-related molecules and the activation of immune cells.Inhibit the expression of IL-4, IL-5 and IL-13 in the colon and reduce the activity of myeloperoxidase in the colon.	The allergic symptoms have significantly improved. The number of friction/ scratching within 10 minutes has decreased significantly, alleviating the inflammation and damage to the nasal mucosa.	Fermented red ginseng and ginsenoside Rd can effectively alleviate allergic rhinitis through a dual mechanism of "inhibiting allergic immune response + regulating intestinal flora". This approach is safe and effective.	Kim, 2019[54]

Scutellaria baicalensis Georgi	Lamiaceae, Scutellaria, Dry roots	Baicalin,	A guinea pig model of allergic rhinitis induced by OVA	——	Block the JAK2-STAT5 signaling pathway, block the NF-κB signaling pathway, inhibit the activation of mast cells and the release of inflammatory mediators	Oral administration of baicalin (50, 200 mg/kg) significantly reduced the frequency of nasal rubbing and sneezing in OVA-sensitized guinea pigs, improved the histological changes of the nasal mucosa, and reduced the infiltration of eosinophils.	Wogonin can effectively inhibit the allergic rhinitis reaction induced by OVA in guinea pigs, and it can also suppress the inflammatory response of human mast cells stimulated by LPS by blocking the JAK2-STAT5 and NF-κB signaling pathways.	Zhou, 2016[55]
Curcuma longa	Zingiberaceae, Curcuma, Root	Curcumin	The guinea pig allergic rhinitis model induced by OVA	——	Inhibit the degranulation of mast cells mediated by IgE, and reduce the release of inflammatory mediators such as histamine, chymotrypsin-like enzymes, and leukotrienes. Reduce the content of pro-inflammatory cytokine IL-4 in the nasal lavage fluid, and inhibit the inflammatory cascade reaction caused by immune imbalance.	The curcumin group significantly reduced the frequency of sneezing and nose rubbing, and decreased the severity of tearing and nasal congestion.	Curcumin can alleviate inflammation-related symptoms in a mouse asthma model induced by ovalbumin by inhibiting the activity of NF-κB, and thus may be a safer candidate for asthma treatment.	Thakare, 2013[56]
Astragalus membranaceus	Fabaceae, Astragalus, Root	Polysaccharides	48 adult patients with SAR, Randomly allocated in a 2:1 ratio to the astragalus group (33 cases) and the placebo group	——	Regulate the secretion of Th1/Th2 specific cytokines, inhibit Th2-type immune responses, and reduce allergenic cytokines like IL-5 and IL-13.	The symptoms of runny nose in the astragalus group improved more significantly compared to the placebo group. There were also trends of improvement in other core symptoms (nasal congestion, sneezing, eye itching), as well as in TSS, QoLS, IgE, and nasal eosinophils.	The membranous astragalus has a certain therapeutic effect on seasonal allergic rhinitis.	Matkovic, 2010[57]
Urtica dioica	Urticaceae, Urtica, Cut leaves of Urtica dioica	4-shogaol, 8-dehydrogingerdione, resorcinol, carvacryl acetate, eugenol	In vitro experiment (Including histamine H_1 receptor inhibition experiments, mast cell tryptase inhibition experiments, cyclooxygenase	——	H_1 receptor antagonism, inhibition of mast cell degranulation, inhibition of cyclooxygenase COX-1 and COX-2, prevention of arachidonic acid conversion to prostaglandin precursors, and reduction of broad-spectrum pro-inflammatory prostaglandin production.	The patient's allergic symptoms were alleviated, the degree of nasal congestion was relieved, the amount of nasal secretions decreased, and the duration of symptoms was shortened.	From a mechanistic perspective, it is demonstrated that the extract of nettle plants can inhibit the inflammatory responses associated with allergic rhinitis through multiple targets, thereby providing a scientific basis for its traditional medicinal value.	Roschek, 2009[58]

Abbreviations: WLJP, water-soluble honeysuckle polysaccharide; SAR, seasonal allergic rhinitis.

(Largehead atractylodes rhizome, Asteraceae; official drug name: Baizhu) have been confirmed to enhance intestinal barrier function and reduce intestinal inflammation, thereby ameliorating gut microbiota dysbiosis.[61] Additionally, studies have revealed that certain CHM components of animal origin, such as bee venom and ox spleen, can regulate the balance between Th1 and Th2 cells, improve immune function, and consequently alleviate the symptoms of AR.[16] Recent studies have suggested that, when combined with modern scientific technologies, the bioactive components of CHMs can further enhance the therapeutic efficacy for AR through mechanisms such as immune system regulation and inflammatory response inhibition.

Application of TCM Compound Preparations in Regulating Intestinal Microbiota for the Treatment of Allergic Rhinitis

The application of TCM compound preparations in regulating the gut microbiota has also received increasing attention. Through the synergistic effects of multiple medicinal herbs, these compound preparations can regulate the balance of the gut microbiota in a more comprehensive manner (as shown in Table 2). For instance, Xiaoqinglong Decoction (XQLD), a classic TCM compound, has been confirmed to exert favorable efficacy in the treatment of AR.[62] Relevant studies have demonstrated that XQLD can significantly ameliorate allergic inflammatory responses in AR mice.[9,63] High-throughput sequencing technology was used to analyze its impact on the gut microbiota, and the results indicated that the gut microbiota of mice tended to return to a normal state after XQLD treatment, showing significant differences compared with the loratadine (a Western medicine) group.[9] Mahuang Fuzi Xixin Decoction (MFXD) is another traditional TCM decoction. Ding et al found that MFXD suppressed nasal epithelial pyroptosis by inhibiting the NLRP3/Caspase-1/GSDMD-N signaling pathway, thereby alleviating AR.[64] These TCM compound preparations usually contain a variety of TCM components with immunomodulatory and anti-inflammatory effects, such as *Bupleurum chinense* Franch. (Chinese thorowax root, Apiaceae; official drug name: Chaihu) and *Atractylodes macrocephala* Koidz. (Largehead atractylodes rhizome, Asteraceae; official drug name: Baizhu). These components can affect the composition and metabolic activity of the gut microbiota through multiple pathways.[12] Studies have revealed that these compound preparations not only improve the diversity of the gut microbiota but also increase the abundance of beneficial bacteria and reduce the level of pathogenic bacteria, thereby effectively alleviating AR symptoms.[27] Furthermore, the holistic regulatory effect of compound preparations gives them greater advantages in AR treatment—they can further enhance therapeutic efficacy through the interaction of the gut-lung axis.[9] For example, Yupingfeng Powder enhances the body's disease resistance, promotes the activation of Th1 cells, and inhibits the overreaction of Th2 cells, thereby effectively alleviating AR symptoms.[27] In addition, network pharmacology studies have also revealed the potential of TCM compounds in regulating immune-related signaling pathways, such as the NF-κB and MAPK signaling pathways, which play crucial roles in allergic reactions. Future research should continue to explore the specific mechanisms of TCM compound preparations in regulating the gut microbiota, with the aim of providing new insights and approaches for the treatment of AR. It is important to emphasize that TCM is not a monolithic concept but exhibits significant intrinsic heterogeneity, which directly affects the reproducibility of its gut microbiota regulatory effects. Furthermore, the core TCM principle of "treatment based on syndrome differentiation" implies syndrome-specific gut microbiota regulatory mechanisms. AR syndromes link to distinct gut microbiota dysbiosis: Wind-cold syndrome correlates with reduced beneficial bacteria (Bifidobacterium/Lactobacillus) and SCFAs; wind-heat syndrome with increased pro-inflammatory bacteria (Enterobacteriaceae spp.) and inflammatory mediators. TCM targets these differences: Pungent-warm herbs (eg, Huangqi) for wind-cold boost SCFAs-producing bacteria; pungent-cool herbs (eg, Scutellaria baicalensis) for wind-heat suppress pro-inflammatory bacteria, supporting individualized AR treatment.

Application of TCM in Regulating Intestinal Microbiota for the Treatment of Allergic Rhinitis

The Regulatory Effect of TCM on Gut Microbiota

Bioactive components in TCMs influence the composition and function of the gut microbiota through direct and indirect dual mechanisms.[74] Studies have demonstrated that numerous TCM components, such as polysaccharides, flavonoids, and alkaloids, can promote the growth of beneficial bacteria while inhibiting the proliferation of pathogenic bacteria, thereby improving gut microbiota balance.[75] Specifically, the direct regulatory pathway involves polysaccharides (eg,

Table 2 The Application of TCM Compound Preparations in Regulating the Intestinal Microbial Flora for the Treatment of AR

Compound Preparation	Composition	Model	Microbiota Regulation	Related Mechanism	Therapeutic Effect	Result	References
Shenling Tongqiao powder (SLTQP)	*Nelumbo nucifera* Gaertn., *Coix lacryma-jobi* L. var. ma-yuen (Rom.Caill). Stapf, *Wolfiporia extensa* (Peck) Ginns, *Platycodon grandiflorus* (Jacq). A.DC., *Lablab purpureus* (L). *Sweet,Codonopsis pilosula* (Franch). Nannf., *Atractylodes macrocephala* Koidz.	The rat model of CRS induced by Staphylococcus aureus	——	Dual inhibition of TGF-β1/Smad and Wnt/β-catenin signaling pathways, IL-1β↓, IFN-γ↓, TGF-β1↓, ZO-1↑	Significantly reduced the number of nose scratching and sneezing in rats, and restored the weight gain of the model rats	STQLP can significantly reverse the EMT phenotype induced by TGF - β 1 in CRS rats and cells, alleviate sinusitis, and improve the structural damage of nasal mucosa by simultaneously inhibiting the TGF - β 1/Smad and Wnt/β - catenin signaling pathways.	Liu, 2025[65]
Biyuan tongqiao granules (BYTQG)	*Magnolia denudata* Desr., *Ephedra sinica* Stapf, *Xanthium sibiricum* Patrin ex Widder, *Angelica dahurica* (Fisch. ex Hoffm). Benth. et Hook. f., *Mentha haplocalyx* Briq., *Ligusticum chuanxiong* Hort., *Scutellaria baicalensis* Georgi, *Forsythia suspensa* (Thunb). Vahl, *Chrysanthemum* indicum L., *Trichosanthes kirilowii* Maxim., *Rehmannia glutinosa* (Gaertn).	Patients with AR	——	Inhibit the activation of the TLR4/NF-κB signaling pathway, By targeting PTGS2, PTGS1, etc., and mediating signal pathways such as MAPK and HIF-1, Regulate the balance of Th1/Th2/Th17 cell subsets and inhibit allergic reactions, IL-4↓, TNF-α↓	Significantly reduce symptoms such as sneezing, runny nose and nasal congestion.	The efficacy of BYTQG combined with Western medicine in treating allergic rhinitis is superior to that of Western medicine alone. It can effectively alleviate symptoms, regulate inflammatory responses, reduce the recurrence rate, and has good safety.	Chai, 2025[66]

(*Continued*)

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Table 2 (Continued).

Compound Preparation	Composition	Model	Microbiota Regulation	Related Mechanism	Therapeutic Effect	Result	References
Jingfang Granules (JF)	——	The mouse model of AR induced by OVA and aluminum hydroxide	——	GADD↓, ATF4↓, p-eIF2α↓, p-IRE1α↓, XBP1s↓, p-PERK↓, IgE↓, IL-4↓, IL-6↓, IL-13↓, TNF-α↓, IFN-γ↑	JF can effectively alleviate the allergic rhinitis symptoms in mice induced by OVA and aluminum hydroxide, and reduce allergic behaviors such as nose scratching and sneezing.	JF has therapeutic effects on the damage and inflammation of the mouse nasal mucosa induced by OVA/ hydroxyaluminum. The core mechanism by which it exerts anti-AR pharmacological effects lies in regulating the endoplasmic reticulum stress signaling pathway and inhibiting related metabolic and inflammatory pathways.	Wang, 2025[67]
XQLD	*Glycyrrhiza uralensis* Fisch., *Ephedra sinica* Stapf, *Paeonia lactiflora* Pall., *Schisandra chinensis* (Turcz). Baill., *Zingiber officinale* Roscoe, *Neolitsea cassia* (L). Kosterm., *Asarum heterotropoides* F.Schmidt, *Pinellia ternata* (Thunb). Makino	The AR mouse model induced by OVA	Lactobacillus↑, Helicobacter↑, Dubosiella↑	Improving respiratory allergic inflammatory responses through the gut-lung axis, SCFAs↑, HDACs↓, IgE↓, IL-4↓, IL-5↓, IL-13↓	Significantly reduce the frequency of sneezing and nose rubbing in AR mice within 10 minutes, and alleviate nasal sensitivity symptoms	XQLD can effectively treat allergic rhinitis in mice induced by OVA. The mechanism may be through regulating the imbalance of intestinal flora, thereby affecting the function of the gut-lung axis and short-chain fatty acid metabolism, inhibiting the activity of HDACs to regulate immune balance, and ultimately reducing inflammatory responses and alleviating nasal symptoms.	Liu, 2024[9]

MFXD	*Ephedra sinica* Stapf, *Aconitum carmichaelii* Debx., *Magnolia denudata* Desr.	The AR mouse model induced by OVA, The HNEpCs model stimulated by LPS combined with ATP	____	By inhibiting the NLRP3/Caspase-1/GSDMD-N signaling pathway, NLRP3↓, ASC↓, Caspase-1↓, p10/p20↓, GSDMD-N↓, IL-1β↓	Significantly improve the nasal symptoms of AR mice, reduce nasal mucosa swelling, lower IgE and histamine levels, alleviate the histopathological changes of nasal mucosa tissue, and inhibit pyroptosis of nasal mucosal epithelial cells, A dose of 50 μg/mL MFXD can significantly alleviate the cytotoxicity of HNEpCs induced by LPS/ATP.	The MFXD can inhibit pyroptosis of nasal epithelial cells by suppressing the NLRP3/Caspase-1/GSDMD-N signaling pathway, thereby alleviating the inflammatory response and related symptoms of allergic rhinitis.	Ding, 2024[64]
Cangerzisan (CEZS)	____	A guinea pig AR model was established by using aluminum hydroxide for basic sensitization and OVA for local sensitization.	____	GATA-3↑, T-bet↓, HMGB1↓, TLR4↓, p-NF-κB/NF-κB↓	Reduce the infiltration of inflammatory cells in the nasal mucosa of guinea pigs, including the infiltration of goblet cells and mast cells.	The mechanism of CEZS in treating AR involves regulating the expression of key proteins (HMGB1, TLR4, p-NF-κB/NF-κB) in the TLR4 signaling pathway, correcting the Th1/Th2 immune imbalance, and modulating the levels of inflammatory and immune factors, thereby effectively inhibiting the progression of AR and demonstrating a favorable therapeutic effect.	Liu, 2024[68]
Mahuang Fuzi Xixin Decoction (MFXD)	*Ephedra sinica* Stapf, *Aconitum carmichaelii* Debx., *Magnolia denudata* Desr.	The AR model of BALB/c mice induced by OVA	Proteobacteria↓, Pseudomonas↓, Pseudomonas aeruginosa↓, Actinobacteria↑, Bifidobacterium↑	ZO-1↑, occludin↑, IgE↓	Reduce the thickening of nasal mucosa and the proliferation of goblet cells, decrease the secretion of bronchial mucus and the inflammatory infiltration of lung tissue.	The MFXD improves allergic rhinitis by regulating the imbalance of lung microbiota, correcting plasma metabolic disorders, and restoring the epithelial barrier of the lung and nasal mucosa.	Wei, 2023[69]

(*Continued*)

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Table 2 (Continued).

Compound Preparation	Composition	Model	Microbiota Regulation	Related Mechanism	Therapeutic Effect	Result	References
XQLD	*Glycyrrhiza uralensis* Fisch., *Ephedra sinica* Stapf, *Paeonia lactiflora* Pall., *Schisandra chinensis* (Turcz). Baill., *Zingiber officinale* Roscoe, *Neolitsea cassia* (L). Kosterm., *Asarum heterotropoides* F.Schmidt, *Pinellia ternata* (Thunb). Makino	A clinical case series study included 33 adult patients with AR sensitized to dust mites. They received 10 weeks of treatment and were followed up for 24 weeks.	Firmicutes/ Bacteroidetes↓, Prevotella_9↓, Dialister↑, Roseburia↑, Bacteroides↑	Regulate the PPAR signaling pathway, IL-2↑, IFN-γ↑	The symptoms have improved somewhat, and there have been no significant changes in safety indicators such as liver and kidney functions, and blood routine tests.	XQLD can achieve long-term relief of allergic rhinitis by regulating the dynamic changes of intestinal flora.	Zhu, 2021[70]
MFXD	*Ephedra sinica* Stapf, *Aconitum carmichaelii* Debx., *Magnolia denudata* Desr.	The AR rat model induced by OVA	Firmicutes↑, Bacteroidetes↑, Anaerotruncus↑, Butyricicoccus↑, Lachnospiraceae↑, Ruminococcaceae↑, Lactobacillus group↑, Butyricicoccus pullicaecorum↑, Proteobacteria↓, Cyanobacteria↓, Bacteroides↓, Bacteroides fragilis group↓	Reverse the imbalance of Th17/Treg, ZO-1↑, IL-10↑, Foxp3↑, IL-17↓, RORγt↓, IL-1β↓, IL-23↓	Significantly reduce the symptoms of nasal itching, sneezing and runny nose in AR rats, Reduce the levels of IgE and histamine in the serum	The MFXD can regulate the intestinal flora structure of allergic rhinitis rats, increase the production of short-chain fatty acids, thereby restoring the Th17/Treg immune balance, reducing inflammatory responses, and ultimately improving the symptoms of allergic rhinitis.	Liang, 2020[71]

Bi min fang	*Astragalus membranaceus* (Fisch). Bunge, *Atractylodes macrocephala* Koidz., *Saposhnikovia divaricata* (Turcz). Schischk., *Paeonia lactiflora* Pall., *Eclipta prostrata* (L). L., *Bupleurum chinense* Franch., *Xanthium sibiricum* Patrin ex Widder, *Glycyrrhiza uralensis* Fisch. ex DC.	Model of AR in patients with lung and spleen qi deficiency syndrome	____	IL-4↓, IgE↓, IL-17↓, IFN-γ↑	The four symptoms - runny nose, nasal congestion, nasal itching, and sneezing - have all shown some improvement.	The results of this trial will provide consolidated evidence of the effect of BMF on AR and the potential mechanism by which BMF acts. This study will be the first to explore the mechanism of action of Chinese herbal medicine on the gut microbiota in AR.	Luo, 2019[72]
Shu-Bi-Lin	*Xanthium sibiricum* Patrin ex Widder, *Angelica dahurica* (Fisch. ex Hoffm). Benth. et Hook. f., *Saposhnikovia divaricata* (Turcz). Schischk., *Magnolia denudata* Desr., *Gentiana scabra* Bunge, *Verbena officinalis* L.	Guinea pig AR model	____	IgG1↓, TXB_2↓, p-LT↓, eNOS↓	Shu-Bi-Lin can effectively alleviate the sneezing and nasal scratching symptoms in guinea pig AR models, but it has no significant improvement effect on rhinorrhea.	Shu-Bi-Lin could alleviate the nasal symptoms of AR, and its mechanism might be related to its inhibitory effect on type I anaphylaxis reactions and eosinophil infiltration in the nasal tissues, as well as the inhibition of some mediators related to AR	Zhao, 2006[73]

Notes: ↑: Indicates a significant increase in the abundance of the gut microbiota; ↓: Indicates a significant decrease in the abundance of the gut microbiota.
Abbreviations: CRS, chronic rhinosinusitis; JF, Jingfang Granules; CEZS, Cangerzisan; SLTQP, Shenling Tongqiao powder; BYTQG, Biyuan tongqiao granules.

Astragalus polysaccharide, Lycium barbarum polysaccharide) acting as prebiotics—these components are not degraded by host digestive enzymes but are specifically recognized and metabolized by beneficial bacteria (eg, Bifidobacterium, Lactobacillus), promoting their proliferation and metabolic activity. In contrast, the indirect pathway involves TCM components (eg, flavonoids from Gouqizi) regulating the intestinal microenvironment: they enhance the secretion of mucin 2 (MUC2) by intestinal epithelial cells, thickening the mucosal barrier, maintaining intestinal pH stability, and reducing reactive oxygen species (ROS) levels—this optimized microenvironment inhibits the adhesion and virulence factor expression of pathogenic bacteria (eg, Escherichia coli) while providing a favorable niche for beneficial bacteria colonization. For instance, certain TCM components can enhance the integrity of the intestinal barrier and reduce intestinal inflammatory responses by increasing the production of SCFAs.[76] Additionally, studies have revealed that traditional TCMs like *Astragalus membranaceus* (Fisch). Bunge (Milkvetch root, Fabaceae; official drug name: Huangqi) and *Lycium barbarum* L. (Barbary wolfberry fruit, Solanaceae; official drug name: Gouqizi) can regulate the gut microbiota and alleviate symptoms of metabolic diseases such as diabetes and obesity—effects closely associated with changes in the gut microbiota.[77,78] Therefore, the regulatory effect of TCM components on the gut microbiota is not only crucial for intestinal health but also provides new insights and approaches for the treatment of related diseases.

The mechanisms by which TCM regulates the gut microbiota and exerts systemic effects primarily involve modulating intestinal microbial metabolites, influencing intestinal immune responses, and improving intestinal barrier function, with clear sequential causal relationships.[79,80] Firstly, multiple components in TCM (eg, polysaccharides, alkaloids) modulate the composition of the gut microbiota through direct and indirect pathways, promoting the proliferation of beneficial bacteria and inhibiting the growth of harmful bacteria, thereby improving gut microbiota balance.[81] Secondly, the altered gut microbiota enhances the production of metabolites such as SCFAs, which act as key signaling molecules to mediate downstream effects.[82] Traditional TCMs such as *Astragalus membranaceus* (Fisch). Bunge (Milkvetch root, Fabaceae; official drug name: Huangqi) and *Lycium barbarum* L. (Barbary wolfberry fruit, Solanaceae; official drug name: Gouqizi) have been confirmed to enhance the host's immune function, reduce inflammatory responses, and thereby alleviate symptoms of chronic diseases by affecting the diversity of the gut microbiota.[83,84] Specifically, SCFAs bind to G protein-coupled receptors (GPR41, GPR43, FFAR3) expressed on intestinal epithelial cells and immune cells (macrophages, dendritic cells, Treg cells), activating the PI3K-Akt/MAPK signaling pathway while inhibiting the NF-κB inflammatory pathway—this regulates the host's immune responses and metabolic status by promoting anti-inflammatory cytokine (IL-10, TGF-β) secretion and suppressing pro-inflammatory cytokines (TNF-α, IL-6).[85] For distal immunity regulation (eg, nasal immunity in AR), the "gut-nasal axis" plays a pivotal role: SCFAs enter the systemic circulation via the portal vein and reach the nasal mucosa, where they directly activate GPR41/43 on local immune cells to modulate inflammatory responses; simultaneously, SCFAs induce the differentiation of intestinal CD4+ T cells into Treg cells, which migrate to the nasal mucosa through the lymphatic circulation, enhancing local immune tolerance. Studies have revealed that certain TCM formulas can improve intestinal barrier function and enhance the body's immune responses through gut microbiota regulation, which in turn exerts a positive effect on diseases such as AR.[86] Research on these mechanisms provides a theoretical basis and practical guidance for the application of TCM in regulating the gut microbiota and treating related diseases.

The Relationship Between Intestinal Barrier Function and Allergic Rhinitis

The intestinal barrier is a complex structure composed of intestinal epithelial cells, tight junctions, mucus layer, and gut microbiota.[87] It plays a crucial role in protecting the intestine from the invasion of harmful substances and maintaining the homeostasis of the internal environment.[88] The main functions of the intestinal barrier include the selective absorption of nutrients, blocking the invasion of pathogens and toxins, and regulating immune responses.[85] Studies have demonstrated that the impairment of the intestinal barrier is closely associated with the development of various allergic diseases, particularly AR. In patients with AR, the decline in intestinal barrier function may allow sensitizing substances in the intestine to enter the body more easily, thereby triggering systemic immune responses and further exacerbating allergic symptoms.[89] Additionally, the integrity of the intestinal barrier is closely linked to the balance of the gut microbiota; dysbiosis of the microbiota can further damage the intestinal barrier, forming a vicious cycle.[26,90]

TCM exhibits unique advantages in intestinal barrier repair. Studies have demonstrated that certain TCM components can promote intestinal barrier repair by regulating the gut microbiota, significantly upregulating the expression of tight junction proteins (eg, ZO-1 and Occludin) in intestinal epithelial cells, and improving intestinal immune function.[30,40] For instance, TCM components derived from *Astragalus membranaceus* (Fisch). Bunge (Milkvetch root, Fabaceae; official drug name: Huangqi) and *Glycyrrhiza uralensis* Fisch. ex DC. (Licorice root, Fabaceae; official drug name: Gancao) have been found to enhance the barrier function of intestinal epithelial cells and reduce intestinal permeability by regulating the PI3K/Akt signaling pathway, thereby alleviating symptoms in patients with AR.[91,92] Additionally, traditional TCM formulas such as Yiqi Jianpi Decoction (a formula for replenishing qi and strengthening the spleen) have been confirmed to ameliorate gut microbiota dysbiosis, promote intestinal health, and consequently exert a positive effect on the treatment of AR.[93] Notably, certain TCM components can increase the abundance of beneficial bacterial groups (eg, Bifidobacterium and Lactobacillus) while inhibiting the growth of harmful bacteria, thereby restoring the balance of the gut microbiota.[94,95] Furthermore, TCM can regulate the level of oxidative stress in the intestine, reduce cell apoptosis, and further protect the function and structure of intestinal epithelial cells, thereby enhancing the stability of the intestinal barrier.[96] Through intestinal barrier repair, TCM not only alleviates the symptoms of AR but also improves patients' overall quality of life, providing a new perspective for the comprehensive treatment of allergic diseases.[12]

The Regulatory Mechanism of TCM on Immune Function

TCM exhibits significant efficacy in regulating immune function, particularly in influencing the function and activity of immune cells such as mast cells, macrophages, and T cells. Studies have demonstrated that TCM can modulate the balance of immune cells through multiple mechanisms. For instance, certain TCM components can promote the proliferation and differentiation of T cells, enhancing their anti-tumor and anti-infection capabilities.[97] Specifically, polysaccharide components in TCM have been found to enhance the activity of natural killer (NK) cells and promote the secretion of IFN-γ, thereby strengthening the body's non-specific immune response.[98] *Scutellaria baicalensis* Georgi (Baikal skullcap root, Lamiaceae; official drug name: Huangqin) and *Glycyrrhiza uralensis* Fisch. ex DC. (Licorice root, Fabaceae; official drug name: Gancao) have been shown to alleviate allergic reactions by regulating the activity of mast cells.[99] Additionally, traditional TCM can improve immune imbalance by regulating the subset ratio of immune cells: it inhibits overactivated Th2 cells and promotes the function of Th1 cells and Treg cells.[100] Furthermore, TCM can regulate the polarization status of macrophages, promoting their transformation into the M1 phenotype, which enhances their anti-inflammatory and anti-tumor capabilities.[101] TCM also modulates the expression of cytokines through various mechanisms. For example, certain TCM components have been found to significantly reduce the levels of pro-inflammatory cytokines such as IL-6, TNF-α, and IL-1β, while increasing the expression of anti-inflammatory cytokines such as IL-10.[3] Another example is β-elemene, a TCM component that has been proven to alter the tumor microenvironment by regulating the NF-κB, MAPK, and STAT3 pathways, thereby enhancing the function of immune cells.[99,102] These findings indicate that TCM can effectively regulate the function of immune cells through a multi-target and multi-pathway approach, providing new insights for the treatment of related diseases.

The clinical application of TCM in regulating immune responses has gained increasing attention, particularly in the treatment of allergic diseases and autoimmune diseases.[103] Clinical studies have shown that in patients with AR treated with TCM, their immune responses are significantly improved, as evidenced by reduced levels of specific IgE, decreased secretion of inflammatory factors such as IL-4 and IL-5, and a significant increase in the levels of IFN-γ and IL-10. This indicates that TCM can effectively regulate the Th1/Th2 balance.[104,105] Furthermore, TCM compound preparations have also demonstrated favorable immunomodulatory effects in cancer treatment, as they can inhibit the growth of tumor cells by enhancing anti-tumor immune responses.[106] For instance, certain TCM compound preparations have been found to significantly increase the proportions of $CD4^+$ and $CD8^+$ T cells, thereby enhancing the body's anti-tumor capacity.[97] Shuanghuanglian Injection has been confirmed to alleviate allergic symptoms by inhibiting mast cell degranulation and reducing IgE levels.[107] These clinical findings suggest that TCM, through regulating the gut microbiota, repairing the intestinal barrier, and improving immune system function, holds broad application prospects in the treatment of allergic asthma. It can provide more individualized and effective treatment regimens for patients (as shown in Figure 3).

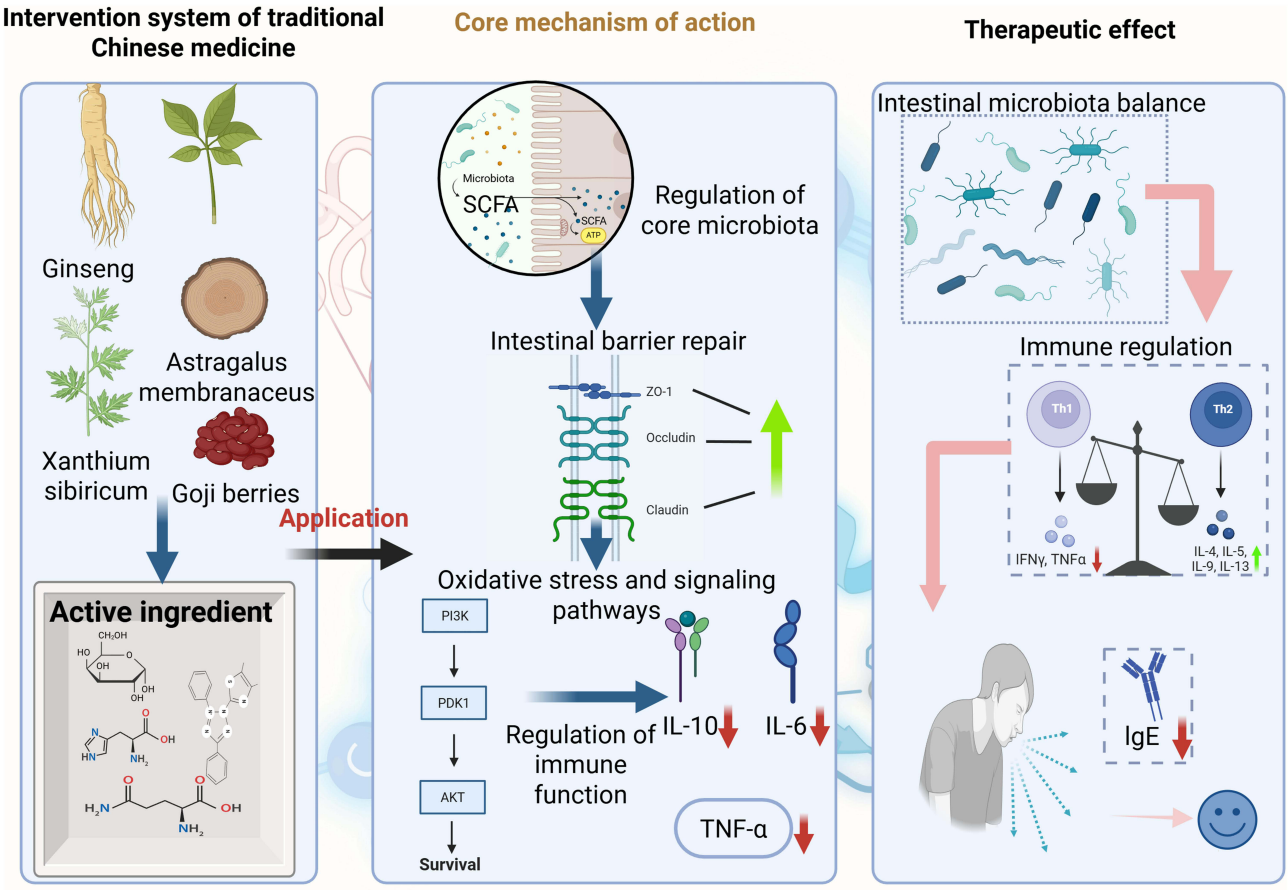

Figure 3 The mechanism of traditional Chinese medicine regulating intestinal microbiota in the treatment of allergic rhinitis. This figure illustrates the intervention system, core mechanism of action, and therapeutic effect of traditional Chinese medicine (TCM). The left part, Intervention system of TCM, presents TCM herbs like *Astragalus membranaceus* (Fisch.) Bunge, *Xanthium sibiricum* Patrin ex Widder, and *Lycium barbarum* L., which exert effects via their active ingredients. The middle part, Core mechanism of action, involves regulating core intestinal microbiota, repairing the intestinal barrier, and modulating immune function (affecting cytokines such as IL-10, IL-6, and TNF-α) through oxidative stress and signaling pathways (eg, PI3K/PDK1/AKT). The right part, Therapeutic effect, shows maintaining intestinal microbiota balance and regulating immunity (balancing Th1/Th2, reducing IgE, etc.), thereby improving health.

The Future Development Direction of TCM in the Treatment of Allergic Rhinitis

TCM has demonstrated promising potential in the treatment of AR. However, its future development still faces numerous challenges and opportunities. First, the primary challenge in research lies in the lack of systematic scientific validation and clinical data support. Although existing studies have indicated that TCM interventions (eg, Xiaoqinglong Decoction) can alleviate AR symptoms by regulating the gut microbiota, these studies still require larger-scale clinical trials to verify their efficacy and safety.[9] Second, the multi-component and multi-target characteristics of TCM result in complex mechanisms of action. In-depth exploration of these mechanisms urgently requires the application of modern biotechnology tools, such as network pharmacology and omics research.[30] Nevertheless, this also presents opportunities for researchers. With the advancement of modern medical technology, integrating the advantages of TCM can facilitate the exploration of novel therapeutic regimens. Researchers can leverage big data analysis and artificial intelligence (AI) technologies to identify the potential applications of TCM in AR treatment, thereby advancing the modernization of TCM.

A comprehensive treatment strategy integrated with modern medicine represents a crucial direction for the future development of TCM in the treatment of AR. Currently, a growing number of studies have focused on the integrated TCM-Western medicine treatment model—for example, combining TCM with modern drugs to enhance therapeutic efficacy and reduce side effects.[108] In clinical practice, for instance, traditional TCM preparations such as nasal TCM sprays have been developed for AR treatment. This non-invasive approach not only effectively alleviates symptoms but

also improves patients' quality of life by regulating immune responses.[109] Additionally, researchers should pay attention to the integration of TCM with modern biotechnology—such as using genomics and metabolomics technologies to explore the mechanisms by which TCM components affect AR—with the aim of providing a scientific basis for personalized treatment.[30] In summary, the future development of TCM in AR treatment will rely on interdisciplinary collaboration, which will promote the modernization and internationalization of TCM.

Limitations

Despite the growing evidence on TCM for AR, critical research gaps remain: First, mechanistic research relies heavily on animal models with uncertain clinical translatability. Most existing mechanistic studies use ovalbumin (OVA)-induced AR mice or rat models, which simulate only part of the pathological features of human AR (eg, IgE-mediated allergic inflammation) but cannot fully replicate the complex etiological factors (eg, genetic–environmental interactions, chronic recurrence) and clinical phenotypes of human AR. Additionally, there are significant species-specific differences in gut microbiota composition between animals and humans—for example, Firmicutes and Bacteroidetes dominate the human gut, while the gut microbiota of laboratory mice is enriched in specific genera such as Lactobacillus and Bifidobacterium under standardized feeding conditions. This discrepancy may lead to inconsistent responses to TCM interventions, making it difficult to directly extrapolate animal-derived mechanistic conclusions (eg, TCM-regulated SCFAs production or gut-nasal axis signaling) to clinical settings.

Second, clinical evidence is insufficient in scale and prone to publication bias. Most clinical studies on TCM for AR are small-scale, single-center trials with sample sizes typically less than 100 cases, lacking large-scale, multi-center randomized controlled trials (RCTs) with rigorous design (eg, placebo controls, blind methods, long-term follow-up). The small sample size limits the statistical power to verify efficacy and identify potential confounding factors (eg, age, AR subtype, concurrent medications). Moreover, publication bias may exist: positive results (eg, symptom relief, IgE reduction) are more likely to be submitted and published, while negative or neutral findings are rarely reported, leading to an overestimation of TCM's therapeutic effects in existing literature.

Third, standardization and homogeneity of TCM interventions are lacking. TCM treatment emphasizes "syndrome differentiation and treatment," leading to variations in herbal formulas, dosages, and treatment durations across studies. For example, Xiaoqinglong Decoction may be modified according to patients' syndromes (eg, adding Glycyrrhiza uralensis for harmonizing ingredients or Scutellaria baicalensis for heat-clearing effects), resulting in inconsistent intervention protocols that hinder cross-study comparison and meta-analysis. Additionally, the lack of in-depth research on the synergistic or antagonistic effects of multi-component TCM makes it difficult to clarify the key active ingredients and optimal combinations for AR treatment.

Conclusion

AR pathogenesis involves environmental–genetic interactions, immune dysregulation, excessive inflammatory mediators, and gut dysbiosis, with gut microbiota imbalance and impaired intestinal barrier playing key roles. This study highlights TCM's unique value in AR treatment by targeting the gut-immune axis, a core innovation beyond conventional symptom relief.

TCM acts via multi-pathways. Chinese herbal medicine (eg, Huangqi, Gancao) and TCM compound preparation (Xiaoqinglong Decoction, Yu Pingfeng San) reshape gut microbiota (increase beneficial bacteria, boost SCFAs, repair intestinal barriers (upregulate ZO-1/Occludin via PI3K/Akt), and rebalance immunity (modulate Th1/Th2/Treg, inhibit NLRP3-mediated pyroptosis). Clinical data confirm symptom relief, reduced IgE, and lower recurrence.

In summary, TCM's multi-target regulation of gut microbiota-intestinal barrier-immune axis provides a safe, effective AR therapy, enriching TCM's application in allergic diseases and guiding clinical practice.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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