# The Mechanism, Clinical Efficacy, and Application Optimization Strategies of Traditional Chinese Medicine in Combating Influenza Virus

Huaye Gong *

Northwest A&F University, Shan Xi, China

* Corresponding Author Email: gonghuaye@nwafu.edu.cn

**Abstract.** Influenza is an acute respiratory infectious disease with fever, cough, and general discomfort as the main symptoms after infection with influenza virus, which can cause a certain proportion of deaths. Traditional Chinese medicine (TCM) has made great breakthroughs in the research and development of anti-influenza drugs with its unique effectiveness, and the field is also developing new drugs. A large number of clinical evidence also confirmed that some TCM ingredients such as berberine and forsythin can play a good role in anti-influenza virus in vivo and in vitro. In addition, some compound preparations, such as the Lianhua Qingwen capsule, have even played more important roles in clinical practice than Western medicine alone. However, the metabolic process in vivo and the synergy of different action sites need to be further clarified. Based on the pathogenic mechanism of the influenza virus, this paper further elaborated the mechanism of action of flavonoids, alkaloids, and other active ingredients of TCM on the virus, and then systematically summarized the clinical efficacy and effect of TCM against influenza and the application scheme of improving the combination of drugs. In addition, this topic provides a certain reference value for explaining the mechanism of TCM against the influenza virus and the methods of clinical use of TCM. However, there are still some problems to be further explored, such as the mechanism of TCM ingredients acting on the human body, the mechanism of action between TCM ingredients, and the safety of long-term use.

**Keywords:** Influenza virus, Traditional Chinese medicine (TCM), Anti-influenza mechanism.

## 1. Introduction

Influenza is an acute respiratory infectious disease caused by the influenza virus, which frequently breaks out in the world and seriously threatens human health. Influenza causes about 5% to 10% of adults and 20% to 30% of children to be infected every year. The cumulative number of infections worldwide reaches 1 billion, including 3-5million severe cases and 290000-650000 related deaths [1]. At present, antiviral drugs such as neuraminidase inhibitors are mainly used in clinical treatment, but the continuous enhancement of viral resistance significantly reduces the therapeutic effect of such drugs. In this context, it is particularly important to explore new anti-influenza virus treatments. As an important part of traditional Chinese medicine (TCM) has accumulated rich practical experience in the field of disease prevention and treatment. A number of clinical studies have confirmed that some TCM and its compound preparations have definite therapeutic effects on influenza, which provides an important research basis and development direction for the development of new anti-influenza drugs.

The study of the antiviral mechanism of TCM shows that it has the characteristics of a multi-target effect. The chemical components contained in heat clearing and detoxifying herbs such as Taraxacum mongolicin and Houttuynia cordata achieve pathogen inhibition by specifically interfering with viral nucleic acid synthesis and structural protein expression. The active components of typical drugs have a significant blocking effect on the adsorption process of influenza virus [2]. At the level of immune regulation, specific components of TCM can regulate the balance of Th1/Th2 cytokines and maintain a steady state of immune response. Clinical evidence-based research confirmed that the classic prescription Guizhi plus Gegen Decoction showed a clear intervention effect in the treatment of viral pneumonia [3]. Randomized controlled trial (RCT) data show that Lianhua Qingwen (LHQW)

preparation has the same efficacy and excellent tolerance as traditional neuraminidase inhibitors in the remission rate of influenza-related symptoms and the shortening of disease duration [4].

This paper aims to elaborate on the pharmacological effect and clinical application value of TCM in the field of influenza virus prevention and treatment, through an in-depth analysis of the antiviral mechanism of a variety of active ingredients of TCM, combined with the existing clinical research data, to explore the actual effect of TCM preparations in the treatment of influenza. The results show that TCM exerts an antiviral effect through multi-target and multi-channel synergistic mechanisms, and its clinical application shows unique advantages.

## 2. Basic Pathological Mechanism of Influenza Virus

### 2.1. Structure and Classification of Influenza Viruses

Influenza virus belongs to the family Paramyxoviridae. It is a single-strand negative-strand segmented RNA virus. Its structure is core, matrix protein, and envelope from inside to outside. The core contains the viral genome and nucleoprotein. The genome is composed of 8 RNA segments encoding 10 proteins such as hemagglutinin (HA) and neuraminidase (NA); The matrix protein (m) forms the viral capsid and maintains the viral morphology; The envelope is derived from the host cell membrane and embedded with two glycoprotein spikes, HA and Na. Ha mediates the binding and membrane fusion of the virus and host cell receptor, and Na participates in the release of the virus (Figure 1) [5].

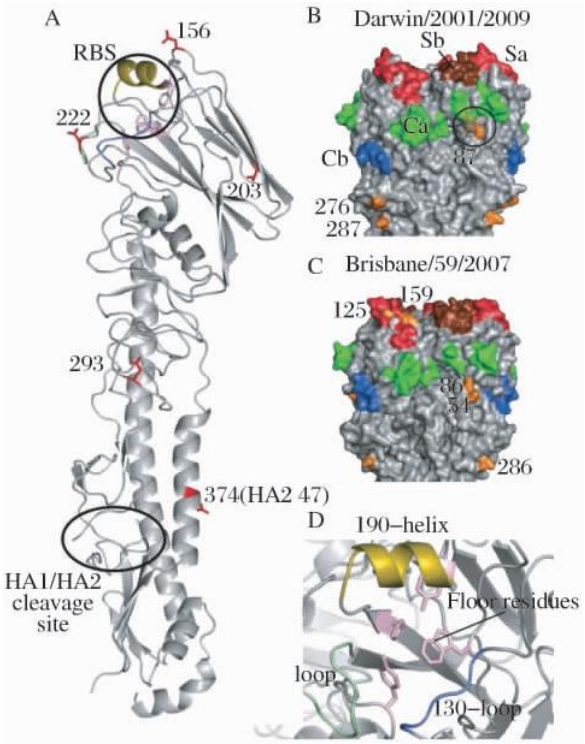


**Figure 1.** Structure of HA protein monomer of influenza A (H1N1) virus [6]

According to the antigenicity of nucleoprotein (NP) and matrix protein (MP), influenza viruses are divided into three types: A, B, and C. Type A can infect a variety of hosts such as humans, poultry, and pigs. According to the different combinations of HA (subtype 1-18) and Na (subtype 1-11), influenza viruses are further divided into multiple subtypes, such as H1N1, H5N1, etc; Type B and type C mainly infect humans, and the classification of subtypes is relatively simple. Avian influenza virus belongs to type A influenza virus, which contains a variety of combinations of HA and Na subtypes. Its receptor binding specificity is closely related to the host range. For example, the avian influenza virus mostly binds the sialic acid α-2,3 galactose receptor, while the human influenza virus tends to bind the sialic acid α-2,6 galactose receptor [7].

### 2.2. Infection and Pathogenesis of Influenza Virus

The virus is transmitted through the respiratory tract, and the initial adsorption is completed through the binding of hemagglutinin protein and the receptor on the surface of epithelial cells. Then it enters the cell through internalization, completes genome replication and structural protein synthesis by using host organelles, and finally releases mature virus particles by budding. [6]

Influenza virus infection may induce cell apoptosis. This mechanism plays an important role in maintaining homeostasis, but excessive apoptosis may lead to tissue damage. Influenza virus infection can cause multiple system complications: in respiratory complications, some hospitalized patients may aggravate acute respiratory distress syndrome, including diffuse alveolar injury and hyaline membrane formation. Among the complications of the muscle system, rhabdomyolysis also has a low incidence. Severe cases can be complicated with acute kidney injury, and its pathophysiological mechanism may involve direct virus invasion of muscle cells or immune-mediated muscle fiber destruction [8]. In addition, the frequency of nervous system complications in cold children recorded in different reports ranged from 1.7% to 18% [9].

## 3. Analysis of Effective Components of TCM against Influenza Virus

### 3.1. Flavonoids

Flavonoids are one of the important active ingredients of TCM against the influenza virus. Their anti-influenza effect covers many aspects, such as inhibiting virus replication, regulating host immunity, and affecting the activity of key viral enzymes. Flavonoids with different structures show diverse characteristics. Flavonoids, based on c6-c3-c6, can be divided into flavonoids, flavonols, dihydroflavones, and other subclasses, which are widely found in honeysuckle, Scutellarin baicalensis, and other Chinese medicinal materials.

The mechanisms of flavonoids against influenza viruses include inhibiting virus replication, directly acting on virus particles, and regulating host immunity. Flavonoids contained in TCMs such as Forsythia suspensa, honeysuckle, and Chrysanthemum indicum can inhibit the sialidase activity and membrane fusion process of the influenza virus; Baicalin can inhibit the combination of influenza virus and CD4 receptor, and can also enhance the SOD activity of myocardial tissue, which plays a role by enhancing the function of endogenous oxygen free radical scavenging system. Bioflavonoids such as amentoflavone and Kadsura flavone have significant inhibitory effects on influenza viruses A and B, which may be related to interference with virus replication or RNA release. The anti-influenza virus activity of flavonoids is closely related to its structure. Flavonols such as quercetin have broad-spectrum antiviral activity. Flavanols and flavonols have a stronger inhibitory effect on herpes simplex virus (HSV) than flavonoids. Flavonoids have a stronger inhibitory effect on cytomegalovirus (HCMV), while naringenin (flavanone) has no inhibitory activity on HCMV, which may be related to the fact that its aromatic rings are not in the same plane. The number and location of hydroxyl groups on the mother nucleus have a significant impact. For example, when there are hydroxyl groups at positions 5 and 7 and hydroxyl groups at positions 6, the anti-HIV activity is significantly increased, but the increase of hydroxyl groups may reduce the activity in the anti-Epstein Barr virus (EBV-EA). Methoxylation is usually unfavorable to the activity, but the 3-methoxy group may enhance the activity. For example, the anti-EBV-EA activity of 3,5,6,7,8,3 ', 4 "-heptamethoxyflavone (HPT) increases with the increase of the methoxy group. Glycosylation leads to a decrease in activity. For example, the anti-HSV-1 activity of quercetin decreases after the glycosylation at position 3, but the anti-HIV activity of quercetin increases after the glycosylation at position 3 with gallate [10].

From the perspective of the source of TCM, Perilla frutescens is a common medicine of Yi people, and its flavonoids are the main active ingredients against the influenza virus [11]; Flavonoids in Yinqiao Powder come from mint, Schizonepeta tenuifolia, Glycyrrhiza uralensis, honeysuckle and other herbs, reflecting the characteristics of multi-component synergy of TCM [12]. These studies

show that flavonoids play an important role in the anti-influenza virus of TCM, and their structural diversity provides a direction for further development.

### 3.2. Alkaloids

Alkaloids are an important class of nitrogen-containing organic compounds in TCM. Their significant physiological activities show unique value in the field of anti-influenza virus. A variety of indole alkaloids contained in Radix Isatidis, such as progoitrin, goitrin, and epigoitrin, have a dose-dependent inhibitory effect on MDCK cells infected with influenza A virus (H1N1) in vitro. Progoitrin has the strongest activity, and its mechanism is related to the interference of virus adsorption or budding by attaching to the virus envelope. Indirubin and its derivative indirubin-3'-oxime, another important component, can inhibit the expression of RANTES in influenza virus-infected cells, downregulate the phosphorylation of NF - κ B regulatory molecules I κ B - α and p38 MAP kinase, and promote the production of IFN - β and IFITM3 by regulating Mavs signaling pathway, thus reducing lung injury in stressed mice [13].

In addition, as for the total alkaloids (TA) of the glucopectin tree, it was found that its Picrinine, Valles amine, and other components play an anti-influenza role by regulating the innate immune response. TA can inhibit viral replication in A549 cells and U937-derived macrophages, reduce the mRNA and protein levels of TNF - α, IL-6, and other pro-inflammatory factors, and block the signal transduction activated by pattern recognition receptor (PRR) and IFN. It can regulate the expression of TLR-3, RIG-I, MDA-5, and other proteins, inhibit the phosphorylation of IRF-3, p65, STAT1/2, and the activation of downstream isg-15. In the H1N1 lethal mouse model, TA can improve the survival rate, reduce the virus titer and immune cell infiltration in lung tissue, and improve the pathological injury of lung tissue. Its mechanism is related to the intervention of RIG-I/MDA-5/TLR3 dependent signal cascade and IFN system activation [14]. Matrine alkaloids, such as Oxymatrine, have a significant inhibitory effect on influenza A virus (H1N1) in vitro, with IC50 of 19.95 μ mol/L and selection index (SI) of 739.35. The mechanism study showed that Oxymatrine could inhibit the release of inflammatory factors such as IL-1 β, IL-6, and TNF - α by blocking the tlr4-myd88-traf6-nf - κ B signaling pathway, thereby reducing the virus-induced inflammatory response. In addition, the inhibitory effect of sophocarpine, sophoridine, and other components on the Coxsackie B3 virus indirectly reflects the broad spectrum of alkaloids in the field of antiviral, which play a role by directly inactivating the virus, inhibiting viral protein synthesis and regulating immune function, such as increasing interferon - α and reducing TNF - α level [15].

Alkaloids from different sources of TCM have synergistic effects against the influenza virus through multiple targets, including direct intervention in the virus life cycle and regulation of host immune and inflammatory pathways, which provide an important basis for the development of anti-influenza TCM.

### 3.3. Other Ingredients

In addition to flavonoids and alkaloids, there are many types of TCM ingredients that have been confirmed to have anti-influenza virus activity, and their mechanisms of action are diverse, providing a rich direction for the research and development of anti-influenza drugs.

Terpenoids also have anti-influenza effects. Andrographolide, neo andrographolide, and 14-deoxy-11,12-dihydroandrographolide have a good inhibitory effect on herpes simplex virus type 1 (HSV-1) in vitro, with IC50 of 8.28, 7.77 and 11.1mg · L-1, respectively. Andrographolide and 14-deoxy-11, 12-dihydroandrographolide also have an anti-HIV effect in vitro, and their derivatives have even stronger anti-HIV activity [16].

Phenolic acids also play a role in the anti-influenza virus. Gardenia extract ZG has an obvious inhibitory effect on influenza virus and other viruses. In the mouse model of influenza virus pneumonia, gardenia extract ZG could significantly inhibit lung inflammation, reduce mortality, prolong survival time, and reduce the content of no in serum; In vitro experiments using the CPE

method found that it has a significant inhibitory effect on the cytopathy caused by six viruses such as influenza A virus and parainfluenza virus type 1 [17].

In addition, there are other types of ingredients with anti-influenza virus activity. For example, fruitarian-(1 → 4)-glucopyranose (FG), a disaccharide compound isolated from Radix Isatidis, has been proved to have good anti-influenza A virus activity in vitro; The in vitro activity of the lignan compound clemastanin B isolated from the crude extract of Isatis indigotica root proves that it has the same specific antiviral activity as the crude extract of Isatis indigotica root [16].

These different types of TCM ingredients play the role of anti-influenza virus by directly inhibiting virus replication, affecting virus adsorption, regulating body immunity, and other ways, providing a rich material basis and theoretical basis for the in-depth research and development of anti-influenza TCM.

## 4. Clinical Evidence

### 4.1. Clinical Effect of TCM in the Treatment of Influenza

Because of its multi-component synergistic effect, TCM compound preparations can exert curative effect in multiple ways and show multiple effects in the prevention and treatment of influenza. For example, Isoquercitrin showed dose-dependent antibacterial activity in vitro, with $EC_5$ in the range of 42.63~48.90 μ g/ml and Si > 10, proving that Isoquercitrin has certain antiviral activity and safety performance [18]; Arctigenin at the concentration of 13.4mmol/l can completely inhibit the hemagglutination titer of influenza A virus up to 87.5%, and when its concentration rises to 26.8 mmol/l, it can completely inhibit the replication of the virus, indicating that it has a direct antiviral effect [19]; Two flavonoids were screened from the extract of Perilla frutescens. In vivo, the EC50 of the two flavonoids on H1N1 was 26.16 ± 0.51 μ mol/l and 21.51 ± 0.56 μ mol/l, respectively, which confirmed their potential anti influenza virus effect [11].

Clinical use has proved that some TCM compounds and active ingredients have definite curative effects. For example, the clinical trial of sophocarpine injection in patients with viral myocarditis found that the negative conversion rate of serum Coxsackie virus RNA was 83.3%, which can significantly improve the main symptoms such as palpitation and chest tightness, improve the activity of natural killer cells, and regulate T lymphocyte subsets [15]; LHQW capsule has been found in vitro that the product can play an antiviral role by blocking the adsorption, replication and killing of viruses through multiple links. It has a significant inhibitory effect on influenza A virus and Coxsackie B4 virus in vitro. It can be used in the treatment of influenza in clinic, which can effectively reduce the inflammatory lesions of lung tissue and prolong the survival time [16].

### 4.2. Auxiliary Effect of TCM in the Treatment of Influenza

In addition to its direct antiviral effect, TCM can also assist in the treatment of influenza.

In terms of immune regulation and inflammation control, the active ingredients of TCM can balance the immune response by interfering with multiple signaling pathways. In vitro and in vivo experiments have proved that Is quercitrin can inhibit the activation of NF - κ B signaling pathway induced by influenza virus infection, inhibit the secretion of inflammatory factors such as TNF-a and IL-1 β, and promote the secretion of type I interferon (IFN - α/β) [18], so as to achieve the purpose of "inhibiting excessive inflammation and enhancing antiviral immunity". In addition, studies have shown that Oxymatrine inhibits the excessive secretion of inflammatory factors such as IL-6 and IP-10 caused by influenza virus infection by down regulating the tlr4/myd88/traf6 signaling pathway, and up regulating the pi3k/akt signaling pathway to enhance cell survival, which can reduce the apoptosis of myocardial cells in the Coxsackie B3 virus infection model [15]. Indirubin in Radix Isatidis can promote the expression of IFN - β and IFITM3 proteins to enhance the antiviral ability of the host by regulating the mitochondrial antiviral signaling protein (MAVs) pathway and can inhibit the sensitivity of mice to influenza virus infection in a stress state [13].

It is hoped to improve the efficacy of traditional antiviral drugs and reduce the drug resistance rate by using a combination of TCM and Western medicine or a combination of TCM and chemical drugs. When sophocarpine is combined with guanidine hydrochloride, it can show a synergistic effect and has a stronger effect on CVB3 virus infection than that of single drug. This may be because sophocarpine can directly inactivate the virus and/or promote the production of interferon in host cells [15].

In addition, based on the results reported in previous literature, the comprehensive efficacy of TCM compound has been confirmed to some extent; The domestic research results of LHQW capsule showed that the drug achieved antiviral effect by inhibiting virus adsorption, inhibiting virus replication cycle and regulating immunity, and the inhibition rate of influenza A virus FM1 strain in vitro reached 91.8%; And it can significantly reduce the viral load in patients' lung tissue and shorten the duration of fever [16]. Sophocarpine injection for viral myocarditis can restore cd4+/cd8+to normal, and increase the activity of natural killer cells to 17.14%, indicating that it has the effect of regulating immunity [15].

The adjuvant effect of TCM in the treatment of influenza is not a single mechanism, but through multi-link collaboration. These effects can not only directly enhance the antiviral ability of the host, but also reduce the risk of complications by improving the overall pathological state, providing a scientific basis for the development of compound preparations or combined medication strategies.

### 4.3. Optimization Strategy of TCM Application

In order to further improve the effect of TCM in the treatment of influenza virus infection, the application of countermeasures of TCM needs to be optimized. The content of indirubin and indigo in Radix Isatidis can be determined by HPLC-ms/ms and other technologies to determine the rational dosage and ensure the stability of clinical efficacy [13]. As for the treatment based on syndrome differentiation, the principle of dialectical treatment is emphasized in TCM. When treating, we must make a specific distinction between the different types of diseases, and then we can prescribe prescriptions for different people. Yinqiao Powder can be applied to the patients with wind heat invading Wei type influenza. The prescription is mainly composed of honeysuckle, forsythia, Schizonepeta tenuifolia, mint, etc., which can play the role of clearing heat and detoxification, dispersing wind and relieving exterior, and can effectively improve the clinical symptoms of patients such as fever, sore throat, cough, etc; While patients with influenza of wind cold bundle phenotype should apply jingfangbaidu powder, use Schizonepeta tenuifolia and Fangfeng to dissipate wind cold, and use notopterygium Incisum and Angelica pubescens to remove wind, dampness and pain [16-17]. We should strengthen clinical research and evidence accumulation, and actively carry out large sample, multi center, RCTs, so as to provide scientific basis for the safety and effectiveness of TCM in the treatment of influenza, which is conducive to providing objective evidence for the rational use of TCM in clinic.

The improvement of TCM dosage form is an important link in the improvement and optimization of TCM dosage form. TCM decoction has the problems of inconvenient medication and poor taste. Therefore, it is necessary to develop new dosage forms, such as granules and oral liquid, to improve the acceptance of patients. For example, LHQW granules and Xiaoer Chiqiao Qingre granules retain the comprehensive efficacy of TCM compounds and are easy to carry and take [17]; Nanoparticles of active ingredients of TCM prepared by nanotechnology can improve the bioavailability of TCM. For example, the preparation of quercetin into a nano suspension can significantly increase its absorption in vivo, thereby enhancing its anti influenza effect [20].

From the perspective of prevention, the concept of "preventive treatment" of TCM can also be brought into play. The role of TCM sachets, which enter the human body through the mouth and nose, is to prevent and treat diseases, and is applied to TCM sachets. For example, sachets made of Agastache rugosa, Perrin, and wormwood leaf are worn to prevent influenza virus in the season when influenza virus is prone to occur. At the same time, a reasonable diet according to personal constitution can play a role in strengthening the body and eliminating pathogenic factors. Often eating

yam, lily, mung bean, coix seed and other foods that can help healthy qi and ward off evil can help us maintain good physical condition [16].

Establishing a perfect quality standard system is the basic work of quality control of TCM. Through the standardized cultivation of TCM, the planting environment and cultivation technology of TCM are standardized, so that the quality of TCM varieties is stable; The content of Radix Isatidis can also be greatly improved by building a standardized planting base of Radix Isatidis and strictly complying with the requirements of soil and water sources [13]. In accordance with the traditional processing methods, modern technical means are used to process the medicinal materials, standardize the processing process, and ensure the processing quality. For example, Rehmannia glutinosa adopts the technology of nine steams and nine suns combined with modern drying to accurately control the changes of the effective components of the drugs and ensure the efficacy [11]. The comprehensive quality evaluation of TCM is carried out by using fingerprint to ensure the consistency of quality of TCM and the stability of clinical efficacy of TCM [13].

## 5. Conclusion

This paper mainly studies the anti-influenza virus mechanism and clinical application of TCM and introduces the structural characteristics of the influenza virus, the route of infection, and the anti-virus mechanism of flavonoids, alkaloids, and other active ingredients of TCM. This paper introduces the application methods of TCM combined with the actual clinical curative effect, auxiliary effect, and application optimization methods of TCM. The results showed that TCM has the characteristics of multi-component and multi-target, so it can provide more possibilities for the research and development of anti-influenza drugs, and has a good immune regulation effect, which is conducive to promoting the modernization of TCM and the prevention and treatment of influenza. However, there are still some problems in this field, such as the lack of in-depth study of some TCM ingredients; For the TCM compound, the mechanism of the complex synergy between its components has not been fully understood, there is a lack of long-term follow-up of large samples, and the data used to prove the safety and long-term efficacy of TCM are incomplete. Therefore, research in these aspects can be carried out by using related technologies such as system biology, carrying out large-scale clinical trials, studying its synergy mechanism, and combining it with modern medical technology.

## References

[1] World Health Organization (WHO). Global Influenza Research Report 2025 [OL]. 2025 - 05 - 01 [2025 - 05 - 14].

[2] Han Xue. Research progress on antiviral activity and mechanism of Qingre Jiedu traditional Chinese medicine. Animal Husbandry and Veterinary Science and Technology Information, 2021 (06): 10 – 11.

[3] Dubaoxiang, Fu Yan, Sun Qihui, et al. Characterization of effective components of Guizhi Jiagegen Decoction in the treatment of influenza virus pneumonia based on serum pharmacochemistry of traditional Chinese medicine. Chinese Journal of Experimental Formulary, 2023, 29 (19): 168 – 175.

[4] Ding Y, Zeng L, Li R, Chen Q, Zhou B, Chen Q, et al. The Chinese prescription Lianhuaqingwen capsule exerts anti-influenza activity through the inhibition of viral propagation and impacts immune function. BMC Complementary and Alternative Medicine, 2017, 17 (1): 130.

[5] Wei Chuang'e. Research progress on molecular biological characteristics and immunity of avian influenza virus. Animal Husbandry and Veterinary Science and Technology Information, 2007 (11): 26 – 27.

[6] Hartmann B M, Albrecht R A, Zaslavsky E, et al. Pandemic H1N1 influenza A viruses suppress immunogenic RIPK3-driven dendritic cell death. Nature Communications, 2017, 8 (1): 1931.

[7] Zhang Wenqiang, Song Shaoxia, Wang Tongzhan. Research progress on the structure and function of HA protein of influenza A (H1N1) virus. Acta Virologica Sinica, 2012, 28 (04): 444 – 452.

[8] Li Li, Wang Linghang. Complications of influenza. Foreign Medicine: Virology Volume, 2018 (3).

[9] Lei Yuxuan, Shu Yuelong, Fang Shisong. Research progress of influenza-related central nervous system complications. Acta Virologica Sinica, 2022, 38 (01): 196 – 204.

[10] Gong Jinyan, Zhang Ying, Wu Xiaoqin. Research progress on antiviral activity of flavonoids. Chinese Herbal Medicine, 2008 (04): 623 – 627.

[11] Yang Linyao, Du Jiangchao, Shao Liang, et al. Flavonoids from Perilla frutescens and their anti-influenza activity. Journal of Kunming University of Science and Technology (Natural Science Edition), 2020, 45 (06): 104 – 110.

[12] Shi Yue, Shi Renbing, Liu Bin, et al. Study on flavonoids in anti-influenza virus effective fraction group of Yinqiao Powder. Chinese Journal of Traditional Chinese Medicine, 2001 (05): 32 – 35.

[13] Deng Jiu, Tao Yulong, He Yuqiong, et al. Research progress on anti-influenza virus active components and mechanism of action of Radix Isatidis. Chinese Journal of Traditional Chinese Medicine, 2021, 46 (08): 2029 – 2036.

[14] Zhou H-X, Li R-F, Wang Y-F, Shen L-H, Cai L-H, Weng Y-C, Zhang H-R, Chen X-X, Wu X, Chen R-F, Jiang H-M, Wang C Y, Yang M R, Lu J G, Luo X-D, Jiang Z H, Yang Z-F. Total alkaloids from Alstonia scholaris inhibit influenza A virus replication and lung immunopathology by regulating the innate immune response. Phytomedicine, 2020, 77(prepublish): 153272.

[15] Zhang Mingfa, Shen Yaqin. Research progress on antiviral clinical pharmacological effects of matrine alkaloids. Anti-infection Pharmacy, 2018, 15 (02): 185 – 191.

[16] Xing Shihua, Li Xiaobo. Research progress on antiviral activity and mechanism of action of heat-clearing and detoxifying traditional Chinese medicine. Chinese Pharmacological Bulletin, 2014, 30 (04): 464 – 468.

[17] Wang Yizhong, Cui Xiaolan, Gao Yingjie, et al. Antiviral test of Gardenia extract. Chinese Journal of Traditional Chinese Medicine, 2006 (14): 1176 – 1178.

[18] Luo R, Lv C, Wang T, et al. A potential Chinese medicine monomer against influenza A virus and influenza B virus: isoquercitrin. Chinese Medicine, 18 (1): 144 [2025 - 05 - 27].

[19] Gao Yang, Dong Xue, Kang Tingguo, et al. In vitro anti-influenza virus activity of arctigenin. Chinese Herbal Medicine, 2002 (08): 54 – 56.

[20] Cheng Yu, Chen Siyang, Chao Hong, et al. Comparative study on the effects of seven kinds of flavonoids on lipid metabolism and intestinal flora in mice fed with high-fat diet. Journal of Nutrition, 2025, 47 (01): 83 – 91.