

# Advances in the Study of the Mechanism of Gualou Xiebai Banxia Decoction in the Treatment of Coronary Heart Disease

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**Abstract:** *Gualou Xiebai Banxia Decoction (GXBD) is a commonly used formula for the clinical treatment of coronary heart disease, offering the advantages of wide clinical applicability and an outstanding therapeutic effect. In recent years, it has been demonstrated that Gualou Xiebai Banxia Decoction can improve the clinical symptoms of patients by correcting lipid metabolism disorders, slowing down the level of immuno-inflammation, resisting oxidative stress, improving energy metabolism, protecting endothelial cells, and promoting repair and regeneration of myocardial tissues. The objective of this paper is to present a review of the mechanism of treatment of coronary artery disease with Gualou Xiebai Banxia Decoction, with a view to providing a basis for the clinical application of this approach.*

**Keywords:** Gualou Xiebai Banxia decoction; Coronary heart disease; Pharmacology; Mechanism of action; Clinical application.

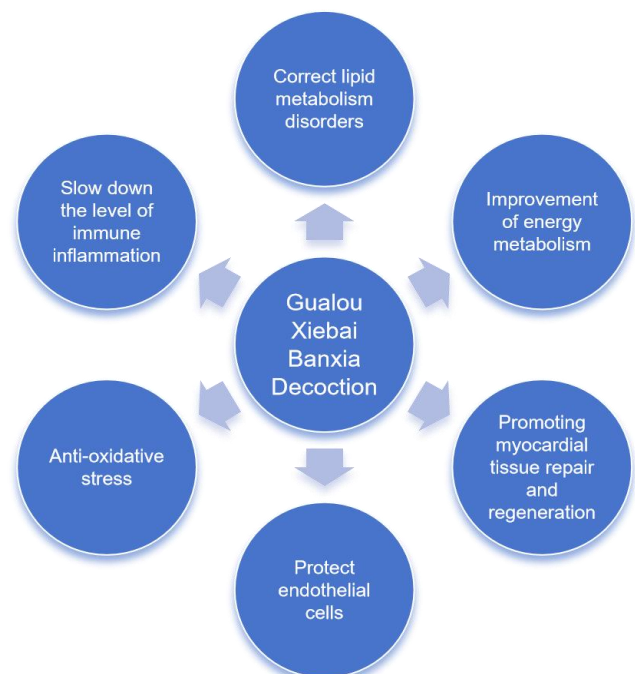
## 1. Introduction

Coronary atherosclerotic heart disease (CHD), also known as coronary heart disease, is a cardiovascular disease caused by the aggregation or rupture of arterial subcortical lipid plaques. This results in impaired coronary microcirculation, which in turn leads to myocardial ischemia, hypoxia, or necrosis [1,2]. China is home to approximately 11.39 million individuals diagnosed with CHD, with morbidity and mortality rates on the rise [3]. In the prevention and treatment of coronary artery disease, anticoagulation is frequently employed to dilate the veins, regulate lipids, and stabilize the plaque, as well as to reconstruct the coronary arteries and restore blood flow when necessary. While the treatment can alleviate patient discomfort, the unpredictable nature of the condition after treatment and the adverse effects of long-term medication remain unresolved. If the condition is not effectively managed, it can result in myocardial infarction and heart failure, which can significantly compromise the physical and mental health of patients.

According to traditional Chinese medicine syndrome, CHD can be categorized as "chest paralysis". With the change of Chinese people's dietary life, syndrome of intermingled phlegm and blood stasis of coronary artery disease has gradually occupied a dominant position in clinical practice [4]. GXBD is from "Synopsis of the Golden Chamber", which can remove obstruction, eliminate phlegm, and soothe chest oppression, and its clinical effect is remarkable when used alone or in combination with other drugs, which can improve clinical symptoms such as palpitation and stuffy pain, shortness of breath and spontaneous sweating [5]. This paper presents a review of the mechanism of action of Allium cepa and Allium cepa hemixia soup in the treatment of coronary heart disease, with the objective of providing a theoretical basis for its subsequent application.

## 2. The Mechanism of Gualou Xiebai Banxia Decoction in the Treatment of Coronary Heart Disease

The pathological mechanism of coronary heart disease is complex and is still being explored. At present, studies suggest that lipid metabolism disorders, endothelial injury, and immune inflammation are the main mechanisms that mediate the onset of coronary heart disease. At the same time, myocardial mitochondrial metabolic dysfunction, oxidative stress, and ferroptosis are also involved in the development of coronary heart disease. In recent years, a large number of basic experiments and clinical studies have shown that Gualou Xiebai Banxia Decoction can affect the pathological state of coronary heart disease in the following ways.



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### 2.1 Correct Lipid Metabolism Disorders

Disorders of lipid metabolism represent an independent risk factor for coronary heart disease [6]. When blood lipids are

abnormal over an extended period, a substantial quantity of oxidized LDL modified by reactive oxygen species is deposited on the vascular wall via the oxidized LDL/LOX-1 pathway, which ultimately leads to the development of coronary heart disease [7]. Yang Qi et al. [8] demonstrated through clinical trials that a soup prepared from GXBD can reduce total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C). Additionally, this treatment has been shown to enhance the functionality of endothelial cells, which may improve the clinical symptoms of patients with CHD. Guo Jianen et al. [9] showed that GXBD could reduce the blood lipid level and reduce the area of vascular plaque in atherosclerotic (AS) model mice, which was related to the reduction of Lox-1 expression. Wang Lei et al. [10] found that GXBD may promote the synthesis and accumulation of cAMP and PKA, activate the activity of PPAR $\alpha$ , and promote the decomposition of fat metabolism by down-regulating the expression of chemerin and CMKLR1 proteins, so as to maintain the dynamic balance of lipid metabolism, and to exert a protective effect against cardiovascular diseases.

In conclusion, GXBD has been demonstrated to exert a beneficial effect on blood lipid levels, as evidenced by the results of both clinical and animal experiments. Additionally, lipid metabolism disorders can interact with other pathological mechanisms of coronary heart disease, such as immune system dysfunction and oxidative stress, thereby exacerbating the condition. The rational modification and combination of the prescription to enhance its therapeutic effect on dyslipidemia represents a significant avenue for the future treatment of coronary heart disease.

## 2.2 Slow Down the Level of Immune Inflammation

Inflammatory factors are important indicators for reflecting the degree of cardiac function damage and judging the prognosis of CHD. Weng Jinlong and colleagues [11] indicate that the consumption of soup prepared from GXBD may serve to attenuate the inflammatory response by inhibiting the TLR4/NF- $\kappa$ B signaling pathway. Zhu Dejian et al. [12] combined Gualou Xiebai Banxia Decoction on the basis of conventional western medicine can reduce the level of plasma MMP-9, reduce the dosage of nitroglycerin, and improve the living standard of patients. The findings of Lin Hui et al. [13] found that Gualou Xiebai Decoction can reduce the level of inflammation, which is related to the inhibition of TGF- $\beta$ 1 / Smads signaling pathway, which is beneficial to the recovery of cardiac function and reverse myocardial remodeling to a certain extent. Gao Fei et al. [14] demonstrated that ApoE<sup>-</sup>/mice exhibited a pathological model of AS when administered Gualou Xiebai Banxia Decoction (20 g/kg, intragastric) for 8 weeks. Inhibition of the NF- $\kappa$ B signaling pathway resulted in a notable reduction in CRP, IL-6, TNF- $\alpha$ , and other inflammatory factors. Concurrently, the expression of vascular cell adhesion molecule-1 (VCAM-1) and cell adhesion molecule-1 (ICAM-1) proteins was suppressed, accompanied by an improvement in blood lipid levels and a subsequent reduction in atherosclerotic lesions.

Gualou Xiebai Banxia Decoction has been demonstrated to regulate the release of TGF- $\beta$ , CRP, IL-6, and other inflammatory mediators by inhibiting multiple signaling

pathways, including TLR4/NF- $\kappa$ B, TGF- $\beta$ 1/Smads, and others. This results in a reduction of inflammatory damage and a delay in the pathological process of coronary heart disease. It is one of the most important ways in which GXBD treats coronary heart disease.

## 2.3 Anti-oxidative Stress

In typical circumstances, the generation of reactive oxygen species (ROS) and the antioxidant system within the body maintain a state of dynamic equilibrium. In myocardial ischemia, antioxidant substances such as superoxide dismutase (SOD) and glutathione (GSH) are consumed in large quantities and their activities are inhibited. Concurrently, elevated reactive oxygen species (ROS) inactivate NO and activate the NF- $\kappa$ B signaling pathway [15]. Conversely, it alters the regulation of the PI3K/Akt/eNOS signaling pathway, shifting it from a state of cell survival to one of apoptosis [16]. The generation of a range of toxic metabolic end products, including malondialdehyde (MDA), further contributes to the pathological damage and functional abnormalities observed in cardiovascular tissues. Qiu Weifeng et al [17] used GXBD combined with Ditan Decoction to treat 30 patients with coronary heart disease and angina pectoris of phlegm turbidity obstruction type for 30 days in clinical practice. It can effectively reduce the level of MDA, increase the level of GSH-Px and SOD, reduce the number of angina pectoris attacks and relieve clinical symptoms. Furthermore, the study revealed that GXBD has the potential to rectify aberrant oxidative stress, neutralize oxygen-free radicals, enhance the body's antioxidant capacity, and stimulate the PI3K/Akt/eNOS signaling pathway, thereby safeguarding myocardial cells [18].

The aforementioned studies have demonstrated that Gualou Xiebai Banxia Decoction is capable of rectifying the anomalous oxidative stress status of the body, impeding peroxidation, safeguarding the structural integrity of the cell membrane and the regular functioning of the ion channel, and augmenting the protective capacity towards the myocardium. Nevertheless, a paucity of clinical data exists to substantiate this assertion.

## 2.4 Improvement of Energy Metabolism

Mitochondrial dysfunction is a pervasive phenomenon throughout the development of CHD, rendering the ATP generated unable to meet the normal cardiomyocyte energy demand [19]. Concurrently, mitochondrial energy metabolism disorders result in an anomalous distribution of charged ions within and beyond the mitochondrial membrane, thereby reducing the membrane potential and prompting the mitochondria to release a series of pro-apoptotic factors, Cyt-C and Bax, into the cytoplasm, which in turn promotes cardiomyocyte apoptosis [20]. This represents a pivotal mechanism underlying the late transformation of coronary heart disease into heart failure. Consequently, the improvement of mitochondrial dysfunction represents a crucial avenue for the treatment of CHD. In animal experiments, Tan Yingying et al. utilized GXBD at concentrations of 2.8, 5.6, and 11.2 g/kg. At the 28-day mark, the results demonstrated that the treatment was capable of restoring cardiac function, reducing the area of interstitial

fibrosis, enhancing antioxidant capacity, and attenuating mitochondrial damage. These outcomes may be attributed to the activation of the AMPK/PGC-1 $\alpha$  pathway [21]. Li Xiang et al [22] showed that GXBD can protect cardiomyocytes by down-regulating the expression of Pink1 / Parkin pathway and inhibiting mitophagy.

Mitochondria serve not only as the site of energy production but also as the center of cellular signal transduction. As a highly energy-consuming organ, the heart's primary source of energy is ATP, which is supplied by mitochondria through oxidative phosphorylation. An adequate amount of ATP is essential for the normal functioning of cardiomyocytes. The aforementioned experiments have demonstrated that *Allium guajava* and *Allium cepa sempervirens* soup can enhance mitochondrial energy metabolism and impede mitochondrial autophagy, which has the capacity to safeguard cardiomyocytes, diminish myocardial pathomorphic alterations, and augment cardiac function. This has the potential to significantly impact the prognosis of coronary artery disease. However, further investigation is required to elucidate the precise mechanism of action.

### 2.5 Protect Endothelial Cells

Endothelial cells are capable of secreting a range of active substances, including PGI<sub>2</sub> and NO, which play a vital role in maintaining vascular tone, regulating blood pressure, and maintaining the equilibrium between coagulation and anticoagulation, thereby facilitating neovascularization and ensuring the optimal flow of blood [23]. When endothelial cells are damaged and dysfunctional, they can stimulate pathological changes, including increased expression of inflammatory cytokines, platelet aggregation, and smooth muscle cell proliferation. These changes can lead to vasospasm and luminal narrowing, which in turn can cause CHD. GXBD can protect endothelial cells by relaxing blood vessels and inhibiting endothelial cell apoptosis. A substantial body of experimental evidence indicates that *Allium guajava* and *Allium sativum* soup reduces endothelin (ET) content and increases NO release in plasma by up-regulating the NO-cGMP pathway. This effect is accompanied by the blockade of calcium ion inward flow, which alleviates myocardial ischemia and ischemia [24]. Chen Wenhao [25] and other experimental results indicate that GXBD can up-regulate the expression of PI3K, m TOR, HIF-1 $\alpha$ , and VEGF proteins, which in turn improves the function of endothelial cells in order to promote angiogenesis and protect cardiac myocardial tissue. After Shen Zhongqi et al. intervened in the Ox-LDL-induced vascular endothelial cell injury model with GXBD, they found that GXBD could down-regulate the expression of pro-apoptotic genes Bax, proteases caspase-9, caspase-3, and protein ALK1, which had the effect of inhibiting apoptosis of endothelial cells [26].

Endothelial injury plays a pivotal role in the pathogenesis of coronary heart disease. Gualou Xiebai Banxia Decoction has been demonstrated to enhance endothelial function, which represents a promising avenue for the treatment of coronary heart disease. However, further investigation is required to elucidate the precise mechanisms of action and identify optimal targets for therapeutic intervention.

### 2.6 Promoting Myocardial Tissue Repair and Regeneration

There are stem cells with the potential of myocardial tissue regeneration in the body, such as human mesenchymal stem cells (hMSCs), endothelial progenitor cells (EPCs), hematopoietic stem cells (HSCs), and cardiac stem cells (CSCs). In the event of a cardiovascular incident such as coronary heart disease, related stem cells are mobilized and migrate to the heart via autocrine or paracrine mechanisms, facilitating the differentiation and homing of endothelial cells and cardiomyocytes. Concurrently, these cells can regulate immunity, promote damaged vascular regeneration and myocardial repair, and enhance cardiac function [27,28]. Xiao et al. [29] implanted hMSCs into patients with heart failure for 6 months, and the cardiac function of the patients was improved. However, the ischemic and hypoxic environment caused by coronary artery disease leads to massive apoptosis of stem cells, greatly reducing their role in myocardial tissue repair, and this has become an urgent problem to be solved [30]. GXBD has the potential of stem cell therapy for cardiovascular disease. Zhao Qitao and colleagues discovered, following comprehensive animal trials, that *Allium guajava* and *Allium sativum* soup could facilitate the mobilization of specific stem cells and inhibit their apoptosis. This phenomenon may be associated with the activation of the PI3K/AKT signaling pathway [31-33].

Stem cell therapy has opened a new avenue for the treatment of coronary heart disease. However, there is still a significant distance to traverse before this approach can be widely adopted and bring positive outcomes to patients with coronary heart disease. The protection of stem cells to enable their biological effects to be sustained over time is of paramount importance in the treatment of cardiovascular and cerebrovascular diseases.

### 3. Summary and Outlook

In conclusion, the consumption of GXBD has been demonstrated to possess the capacity to rectify disorders of lipid metabolism, decelerate the level of immuno-inflammation, and mitigate oxidative stress. Additionally, it has been observed to enhance energy metabolism, safeguard endothelial cells, and facilitate the repair and regeneration of myocardial tissues. These effects are attributable to the soup's therapeutic actions in the management of CHD. Furthermore, clinical studies have corroborated that GXBD, and its modified formulas can markedly enhance clinical symptoms, diminish the frequency of disease recurrence, optimize patient prognosis, and reduce the financial burden of medication for patients. In this regard, GXBD offers a compelling exemplar of the potential of traditional Chinese medicine. Nevertheless, there are numerous avenues for further investigation in the research on the treatment of CHD by GXBD. Firstly, the phenotypes related to coronary heart disease are interfering with each other, which presents a challenge in studying one aspect of the mechanism separately. Secondly, the fundamental research on the treatment of coronary heart disease with GXBD is lagging behind the exploration of coronary heart disease mechanisms. For instance, there is a paucity of research investigating whether GXBD can play a role in CHD by influencing the

intestinal flora. Additionally, there is a dearth of studies examining other potential mechanisms of action. This makes it challenging to fully elucidate the complex systemic nature of GXBD and to gain a comprehensive understanding of its effects within the context of traditional Chinese medicine. Thirdly, we may employ network pharmacology, molecular docking, and other techniques to elucidate the potential mechanism of action, and utilize a research approach combining wet and dry methods to investigate the applications of GXBD in this study. Fourth, the application of mass spectrometry and other techniques to elucidate the material basis of drug efficacy and the relationship between quantity and effect will provide a foundation for future quality control studies. large-sample, standardized, multicenter randomized double-blind clinical trials, at the same time, should be conducted in accordance with the fundamental tenets of traditional Chinese medicine. Finally, it is essential to consider the potential toxicity and adverse effects of GXBD in order to ensure their safe use and facilitate the development and expansion of their clinical applications in the research and development of novel drugs for the treatment of coronary heart disease. This will provide valuable insights and a scientific foundation for the research and development of new drugs for the treatment of coronary heart disease and their expanded application in the clinic.

## References

- [1] LIU Kaiwen, ZHANG Kui, ZHOU Ning, DONG Ran. Advancement in the relationship between gut microbiota and coronary artery disease[J]. Chinese Journal of Clinical Thoracic and Cardiovascular Surgery, 2023, 30(5):746-752.
- [2] WEI Yumiao, YU Liuyu. What is new in the management of coronary artery disease in 2020[J]. Journal of Clinical Cardiology, 2020, 36(7):591-593.
- [3] LIU Ming-bo, WANG Zeng-wu, FAN Jing, HU Sheng-shou. Key points of Report on Cardiovascular Health and Diseases in China 2023[J]. Chinese Journal of Cardiovascular Research, 2024, 22(7):577-593.
- [4] NIU Puyu, LIU Yaoyuan, WANG Hanxiang, LIANG Benzhe, WANG Zeqing, ZHU Gengda, ZHAO Tieniu. Study on Distribution Characteristics of Traditional Chinese Medicine Syndromes in 207793 Patients with Coronary Heart Disease[J]. Chinese Medicine Modern Distance Education of China, 2021, 19(14):201-204.
- [5] ZHANG Ran, HAN Xu. Han Xu's Experience of Treating Coronary Heart Disease from the Heart and Liver[J]. Henan Traditional Chinese Medicine, 2024, 44(7):1061-1065.
- [6] Khatana C, Saini NK, Chakrabarti S, et al. Mechanistic insights into the oxidized low-density lipoprotein - induced atherosclerosis[J]. Oxid Med Cell Longev, 2020, 2020:5245308.
- [7] Tabas I, García-Cardena G, Owens GK. Recent insights into the cellular biology of atherosclerosis[J]. J Cell Biol, 2015, 209(1):13.
- [8] YANG Qi, LIN Hui, WU Guoshui, MAO Ying, CHI Jufang, GUO Hangyuan. Evaluation of Gualou Xiebai Banxia decoction on vascular endothelial function in patients with coronary heart disease by Endo-PAT [J]. Journal of Electrocardiology and Circulation, 2021, 40(1):11-16.
- [9] GUO Jian-en, MI Shu-bin, YAN Xiu-chuan, XIN Si-yuan, GAO Fei, LIANG Guang-he, LI Jing-hua. Effects of Gualou Xiebai Banxia decoction on blood lipid content, oxidative stress and ox-LDL/Lox-1 pathway in ApoE<sup>-/-</sup> mice[J]. China Journal of Chinese Materia Medica, 2017, 42(4):752-757.
- [10] WANG Lei, GUAN Shuai, WU Meng-xue, ZHOU Hui, ZHAO Qi-tao, XUN Li-ying. Gualou Xiebai Banxia Decoction treats type 2 diabetes mellitus combined with acute myocardial infarction via chemerin/ CMKLR1/ PPAR $\alpha$  signaling pathway[J]. China Journal of Chinese Materia Medica, 2024, 49(6):1579-1586.
- [11] WENG Jinlong, XIONG Shangquan, JIANG Shu, ZHENG Feng, LIN Chao, ZHAO Li. Protective Effect and Mechanism of Pretreatment of Gualou Xiebai Banxia Decoction on Myocardial Ischemia-Reperfusion Injury Model Rats[J]. Practical Journal of Cardiac Cerebral Pneumal and Vascular Disease, 2023, 31(12):43-4853.
- [12] ZHU De-jian, WANG Qiang, MIAO Shi-rong, QIN Di, CHEN Qin-yue, HAN Yao-yao, CHEN Hao. The Influence of Trichosanthes and Chinese Chive and Pinellia Decoction on MMP-9 and TIMP-1 of Unstable Angina[J]. Henan Traditional Chinese Medicine, 2021, 41(3):357-360.
- [13] YANG Qi, LIN Hui, LYU Haitao. The effect of Chinese herbal formula Gualou Xiebai Banxia decoction on ventricular remodeling and inflammatory factors after acute myocardial infarction [J]. Journal of Electrocardiology and Circulation, 2020, 39(2):128-132.
- [14] GUO Jianen, GAO Fei, HU Yatao, WU Jinyang, ZHANG Shufeng, DONG Jiming, LI Jinghua. Effects of Gualou Xiebai Banxia Decoction on inflammatory cytokines and the expression of ICAM and VCAM-1 in AS model mice[J]. Journal of Jinan University (Natural Science & Medicine Edition), 2017, 38(3): 234-239.
- [15] QIAO Wanning, CHEN Hongyin, ZHANG Yang. Oxidative stress and atherosclerosis[J]. Chinese Journal of Arteriosclerosis, 2023, 31(4):312-321.
- [16] ZHANG X, HUANG L F, HUA L, et al. Resveratrol protects myocardial apoptosis induced by ischemiareperfusion in rats with acute myocardial infarction via blocking PI3K/Akt/e-NOS pathway[J]. Eur Rev Med Pharmacol Sci, 2019, 23(4):1789-1796.
- [17] QIU Weifeng, LUO Junqiang. Effect of modified Gualou Xiebai Banxia decoction and Ditan decoction on angina pectoris of coronary heart disease with phlegm-turbid obstruction type and its influences on oxidative stress indexes, ET-1, NO, cTnI and vWF levels[J]. Clinical Research and Practice, 2021, 6(29):150-152.
- [18] SUN Diyang, XUN Liying, ZHOU Jidong, YANG Yujie, WANG Lei, ZHAO Qitao. Gualou Xiebai Banxia decoction has a protective effect on type II diabetes mellitus complicated with acute myocardial ischemia by regulating the activation of PI3K/Akt/eNOS pathway by oxidative stress[J]. Journal of Xiamen University: Natural Science, 2023, 62(1):119-126.
- [19] ZHOU Man-li, YU Yun-feng, LUO Xiao-xin, LAN Xiao-dong, JIN Meng-yu, ZHANG Yi-fan, JIAN Wei-xiong. Mitochondrial Dynamics Mediates Myocardial Energy Metabolism in Coronary Heart

- Disease due to Blood Stasis[J]. Chinese Journal of Experimental Traditional Medical Formulae, 2021, 27(21):80-90.
- [20] Chen W, Lv L, Nong Z, et al. Hyperbaric oxygen protects against myocardial ischemia reperfusion injury through inhibiting mitochondria dysfunction and autophagy [J]. Mol Med Rep, 2020, 22(5):4254.
- [21] TAN Yingying, WANG Hui, WANG Yanbing, LI Hong, MA Chengcheng, ZHANG Qi. Effect of Gualou Xiebai Banxiatang on Mitochondrial Dysfunction and AMPK/PGC-1 $\alpha$  Signaling Pathway in Rats with Ischemic Myocardial Injury[J]. Chinese Journal of Experimental Traditional Medical Formulae, 2023, 29(1):9-17.
- [22] LI Xiang, ZHANG Hua-min, CUI Hai-feng, SUI Yu, LI Ying-ying, TANG Dan-li. Effects of Gualou Xiebai Banxia Decoction on autophagy and PINK1/parkin pathway in rats with myocardial ischemia-reperfusion injury [J]. JOURNAL OF BASIC CHINESE MEDICINE, 2020, 26(11):1626-1630.
- [23] MA Xin, LI Yunlun. Study on the Pathological Basis of Blood Stasis Syndrome of Coronary Heart Disease from Vascular Endothelial Cell Injury[J]. Journal of Liaoning University of Traditional Chinese Medicine, 2020, 0(1):117-120.
- [24] DING Zhuxin, ZHU Linping. Research progress on anti-atherosclerosis of Gualou Xiebai Banxia decoction [J]. China's Naturopathy, 2023, 31(6):114-117.
- [25] CHEN Wenhao, MENG Weishan, LI Hong, TIAN Weiwei, ZHANG Qi, TAN Yingying. Effect of Gualou Xiebai Banxiatang on Myocardial Microangiogenesis and HIF-1 $\alpha$ /VEGF-related Pathways in Myocardial Ischemia Model Rats[J]. Chinese Journal of Experimental Traditional Medical Formulae, 2024, 30(17):1-9.
- [26] Shen Zhongqi. Based on ALK1-LDL pathway to explore the mechanism of Gualou Xiebai Banxia Decoction in alleviating ox-LDL-induced vascular endothelial cell injury[D]. Shandong University of Traditional Chinese Medicine, 2021.
- [27] ZHANG Hongqiang, ZHANG Bing, LI Jianqi, JU Hailong. Mesenchymal stem cells for cardiac repair: opportunities and challenges[J]. Medical Research and Education, 2022, 39(5):25-30.
- [28] Wu Ming, Gao Yuping. Research Progress of Myocardial Reparation in Stem Cells[J]. Chinese Journal of Integrative Medicine on Cardio - Cerebrovascular Disease, 2016, 14(20):2383-2385.
- [29] XIAO W T, GUO S P, GAO C Y, et al. A randomized comparative study on the efficacy of intracoronary infusion of autologous bone marrow mononuclear cells and mesenchymal stem cells in patients with dilated cardiomyopathy[J]. Int Heart J, 2017, 58(2):238-244.
- [30] Ju X, Xue D, Wang T, et al. Catalpol Promotes the Survival and VEGF Secretion of Bone Marrow-Derived Stem Cells and Their Role in Myocardial Repair After Myocardial Infarction in Rats[J]. Cardiovasc Toxicol, 2018, 18(5):471-481.
- [31] FU Yao, ZHOU Ji-dong, SANG Xiao-yu, SUN Di-yang, ZHAO Qi-tao, FU Feng-hua. Protective mechanism of Gualou Xiebai Banxia Decoction on hematopoietic stem cells in rats with type 2 diabetes complicated with acute myocardial ischemia[J]. China Journal of Traditional Chinese Medicine and Pharmacy, 2020, 35(5): 2613-2617.
- [32] ZHENG Mengmeng, ZHAO Qitao, ZHOU Jidong, FU Nini, HU Chaoqun, XUN Liying. The effect of Gualou Xiebai Banxia decoction on the mobilization of endothelial progenitor cells in rats of type 2 diabetes complicated with acute myocardial ischemia and its underlying mechanism[J]. Journal of Jinan University (Natural Science & Medicine Edition), 2018, 39(5): 435-441448.
- [33] Jiang Jingjing, Fu Nini, Sang Xiaoyu, Zheng Shuchen, Zhao Qitao. N-Butanol Fraction of Gualou Xiebai Banxia Decoction Inhibits Ischemia-Hypoxia-Induced Apoptosis of Bone Marrow Mesenchymal Stem Cells through PI3K/AKT Signaling Pathway[J]. Pharmacology and Clinics of Chinese Materia Medica, 2021, 37(4):2-7.