Study on the Effect of TLR4/NF-κB Mediated by Resolving Turbidity and Lowering Lipids Tea on the Inflammatory State of Damp-Heat-Internalised Hyperlipidaemia

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Abstract: This study evaluates the lipid-lowering efficacy, anti-inflammatory properties, and safety of Huazhuo Jiangzhi Tea, a herbal formulation comprising Crataegus pinnatifida, Gynostemma pentaphyllum, and Cassia obtusifolia, in 80 hyperlipidemia patients with damp-heat internal retention syndrome. Participants were randomized to receive either the herbal tea or atorvastatin (20 mg/day) for 4 weeks, with assessments of lipid profiles, inflammatory biomarkers, oxidative stress markers, and traditional Chinese medicine (TCM) syndrome scores. Post-treatment, the herbal tea group exhibited significantly greater reductions in triglycerides (1.55±0.13 vs. 1.83±0.14), total cholesterol (5.01±0.56 vs. 6.14±0.47), and LDL-C (3.03±0.24 vs. 3.60±0.14), alongside enhanced antioxidant activity (SOD: 89.75±6.11 vs. 87.16±4.72) and marked suppression of inflammatory mediators (CRP, TLR4, MCP-1, TNF-α, IL-6, sVCAM-1, NF-κB). TCM symptom scores improved more substantially in the treatment group (8.93±4.60 vs. 12.00±5.27), with comparable safety profiles to statin therapy. These findings demonstrate that Huazhuo Jiangzhi Tea effectively modulates lipid metabolism and inflammation through potential TLR4/NF-κB pathway regulation, offering a multi-target herbal approach for managing hyperlipidemia with damp-heat syndrome.

Keywords: Huazhuo Jiangzhi Tea; Damp - Heat Internal Accumulation; Hyperlipidemia with Inflammation; TLR4/NF – κB

1. Introduction

In Traditional Chinese Medicine, hyperlipidemia falls within the realms of “phlegm-dampness” and “blood stasis”, with its pathogenesis closely tied to irregular dietary habits, emotional imbalances, and spleen-kidney dysfunction. According to Chinese medicine principles, overconsumption of fatty and sweet foods can disrupt the transformation and transportation functions of the spleen and stomach, leading to the internal generation of phlegm-dampness. Emotional disturbances can easily cause liver qi stagnation and the accumulation of stagnant qi and congealed blood. Moreover, dysfunction of the spleen and kidneys can result in the internal stagnation of dampness and the internal generation of turbid phlegm[1]. Following the principles of syndrome differentiation and treatment, hyperlipidemia can be categorized into different patterns, such as phlegm-dampness obstruction type, stagnant qi and congealed blood type, and spleen-kidney yang deficiency type[2].

Hyperlipidemia, hypertension, and diabetes, collectively termed as the “three highs”, present significant health threats, raising the likelihood of other chronic conditions and diminishing overall well-being[3]. Controlling lipid levels effectively has emerged as a crucial marker for maintaining health among the broader populace. However, current Western medical approaches to managing hyperlipidemia tend to be narrow in scope, with limitations in treatment efficacy. While many Western lipid-lowering medications, such as statins, bile acid sequestrants, and N-methyl linoleamides, offer some lipid-lowering benefits, they often come with adverse effects like liver or kidney damage and rhabdomyolysis, constraining their prolonged use[4]. In contrast, traditional Chinese medicine (TCM) has shown distinctive advantages in lipid-lowering therapy, gradually gaining widespread recognition for its effectiveness and safety. Lipid-regulating Chinese herbal remedies not only deliver notable reductions in lipid levels but also exhibit gentle yet potent effects,

targeting multiple pathways with fewer adverse reactions. This has led to growing interest and appreciation from both the academic and public spheres[5].

However, current studies predominantly focus on the pharmacological effects of individual Chinese herbal components, overlooking comprehensive investigations into the holistic regulatory mechanisms of compound Chinese herbal formulations. Furthermore, there remains a gap in systematic clinical validation[4, 5]. It is in this context that this study aims to delve into the therapeutic effects and underlying mechanisms of action of Huazhuo Jiangzhi Tea in treating hyperlipidemia, offering fresh perspectives and approaches for the TCM management of this condition.

2. Materials and Methods

2.1 Materials

2.1.1 Study subjects

Eighty patients meeting the inclusion criteria were selected for this study. The participants were all outpatients at the Preventive Medicine Center of Integrated Traditional Chinese Medicine Hospital of Qiannan Prefecture from July 2022 to July 2023. They were randomly divided into two groups: the treatment group and the control group, each comprising 40 individuals. In the treatment group, there were 23 male participants (57.50%) and 17 female participants (42.50%), with an average age of 58.48 ± 14.61 years. In the control group, there were 22 male participants (55.00%) and 18 female participants (45.00%), with an average age of 59.70 ± 11.39 years. The control group received oral atorvastatin calcium tablets, while the treatment group was administered Huazhuo Jiangzhi Tea orally. The duration of treatment for both groups was 4 weeks.

2.1.2 Inclusion and exclusion criteria

Inclusion Criteria: (1) Patients diagnosed with hyperlipidemia. (2) Patients diagnosed with the TCM syndrome of dampness-heat internal accumulation. (3) Age between 18 and 70 years, with no gender restrictions. (4) Not taking lipid-lowering medications for at least 2 weeks. (5) Willing to participate in the study and signed the informed consent form.

Exclusion Criteria: (1) Secondary lipid abnormalities due to systemic diseases or medications. (2) Patients currently taking medications that affect lipid metabolism. (3) Patients with liver or kidney dysfunction (ALT, AST > 1.5 times the upper limit of normal, Cr > upper limit of normal). (4) Pregnant or lactating women. (5) Patients with allergies, known hypersensitivities to multiple medications, or allergies to components of the study drugs.

Criteria for Dropout or Exclusion of Cases: (1) Patients unable to adhere to the study protocol. (2) Patients with incomplete or unstatable data. (3) Patients who could not follow medication schedules, attend follow-up appointments, or affect efficacy assessment. (4) Patients experiencing severe adverse reactions that make further treatment inadvisable. (5) Patients found to not meet the inclusion criteria after enrollment. Any participant who needs to discontinue the trial for any reason at any time or fails to meet the specified study duration will be considered as a dropout case.

2.2 Methodology

2.2.1 Western medical diagnostic criteria

According to the *Guidelines for the Prevention and Treatment of Dyslipidemia in Chinese Adults (2016 Revised Edition)*, the diagnosis of hyperlipidemia is as follows[6]: Total cholesterol (TC) ≥ 5.22 mmol/L; Triglycerides (TG) ≥ 1.72 mmol/L; Low-density lipoprotein cholesterol (LDL-C) ≥ 3.41 mmol/L; or High-density lipoprotein cholesterol (HDL-C) ≤ 1.04 mmol/L. A fasting serum meeting at least one of these conditions is sufficient for diagnosis.

2.2.2 Traditional Chinese Medical Diagnosis and syndrome differentiation criteria

The diagnostic criteria for hyperlipidemia in TCM according to the *Guiding Principles of Clinical Research on New Chinese Medicines* (2002 Trial) and the *Classification and Determination of Traditional Chinese Medicine Constitution* (revised in 2009) are as follows: the syndrome is characterized by dampness-heat internal accumulation. The primary symptoms include oppression in the chest, distending sensations, heaviness in the limbs, and a greasy facial complexion. Secondary symptoms may include thirst with little desire to drink, reduced appetite, listlessness, loose stool, abdominal distention, fullness, nausea, and inclination to vomit. Tongue and pulse examination may reveal a red tongue body, yellow greasy coating, or a rapid number of pulses. The presence of the primary symptoms is essential, and at least one of the secondary symptoms in conjunction with

relevant tongue and pulse conditions is adequate for a confirmed diagnosis.

2.2.3 Experimental methodology

In the experimental procedure, the treatment group was administered the "Huazhuo Jiangzhi Tea" according to the following protocol: (1) Treatment Approach: The therapeutic strategy entailed the clearance of dampness and heat within the system. (2) Composition of Herbal Mixtures: The medicinal blend comprised the "Huazhuo Jiangzhi Tea", containing 4g of Crataegus pinnatifida, 3g of Crataegus pinnatifida, and 2g of Cassia obtusifolia sourced from the Traditional Chinese Medicine Pharmacy of Qiannan Prefecture Hospital of Traditional Chinese Medicine. (3) Administration Regimen: Each pre-prepared tea bag was steeped in 1500ml of water, consumed in single-pack doses 30 minutes post each of the daily meals. Conversely, the control group was administered Atorvastatin Calcium tablets as follows: (1) Prescribed Medication: The drug provided was Atorvastatin Calcium in tablet form. (2) Dosage Protocol: A dose of 20mg, taken orally once nightly. Both groups adhered to this treatment regime for a period of 4 weeks.

Precautionary Measures: (1) Throughout the medication period, patients were instructed to maintain consistent sleep patterns, avoid the consumption of raw, cold, greasy, or spicy foods, refrain from smoking and alcohol, and increase their intake of vegetables and fruits for a balanced diet. (2) Patients were advised to engage in moderate physical activity and sustain a composed mental state, remaining mindful of weather changes to prevent common cold occurrences. (3) Beside the specified experimental medication, the use of any other drugs affecting lipid profiles was strictly prohibited. Furthermore, safety assessments conducted during the trial included: (1) Regular monitoring of vital signs (temperature, respiration, pulse, blood pressure) before and after treatment sessions. (2) Complete blood counts, urinalysis, electrocardiograms, liver and kidney function tests conducted pre and post-treatment to evaluate the impact of the regimen. (3) Close observation for potential adverse reactions including clinical symptoms, physical manifestations, and laboratory findings, meticulously documented for reference. In response to varying degrees of adverse reactions, appropriate steps were taken, including the possibility of discontinuing the ongoing research when deemed necessary.

2.2.4 Observation metrics

Blood Lipid Levels: Total Cholesterol (TC), Triglycerides (TG), Low-Density Lipoprotein Cholesterol (LDL-C), High-Density Lipoprotein Cholesterol (HDL-C); (2) Biochemical Serum Indicators: Assessment of Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), C-Reactive Protein (CRP), Diamine Oxidase (DAO) activity in the serum, and Superoxide Dismutase (SOD) activity; (3) Employing ELISA Technique: Measurement of Tumor Necrosis Factor-alpha (TNF-α), Interleukin-6 (IL-6), Monocyte Chemoattractant Protein-1 (MCP-1), and Soluble Vascular Cell Adhesion Molecule-1 (sVCAM-1) content, along with the activity changes of Nuclear Factor kappa-light-chain-enhancer of activated B cells (NF-κB) and Toll-like Receptor 4 (TLR4); (4) TCM Syndrome Score.

2.2.5 Statistical methodology

For data organization, Excel 2021 was utilized, and data analysis was carried out using SPSS 26.0. Continuous variables underwent Kolmogorov-Smirnov test (n>50) to investigate normal distribution adherence. For data conforming to a normal distribution, mean and standard deviation ($\bar{x} \pm S$) were employed. Conversely, non-normally distributed data were represented using median and quartiles P_{50} (P_{25}, P_{75}). Inter-group comparisons were conducted utilizing independent sample t-tests and non-parametric tests. Categorical variables were expressed as rates (%) or composition ratios (%), with inter-group comparisons analyzed through the chi-square test. The significance level was set at $\alpha=0.05$, with $P<0.05$ indicating a statistically significant difference.

3. Results

3.1 Comparison of Patients' Blood Lipids and Biochemical Indicators

3.1.1 Comparison of blood lipids and biochemical indicators before intervention in two patient groups

The comparison of blood lipids and biochemical indicators before intervention in the two patient groups revealed no statistically significant differences ($P>0.05$). This suggests good consistency among the enrolled patients, making them suitable for interventional trials. Specific

results are illustrated in Figure 1.

3.1.2 Comparison of post-intervention blood lipids and biochemical indicators in two patient groups

Comparison of blood lipids and biochemical indicators after intervention in the two patient groups revealed that the treatment group exhibited significantly lower levels of TG, TC, and LDL-C compared to the control group (P<0.05). Moreover, the treatment group showed significantly higher levels of SOD compared to the control group (P<0.05). Specific results are detailed in Table 1. The treatment group demonstrated superiority over the control group in reducing TG, TC, LDL-C levels, and enhancing SOD levels.

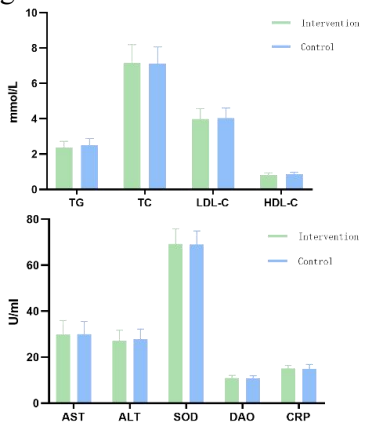

Figure 1. Patients' Blood Lipid and Biochemical Levels

Table 1. Post-intervention Blood Lipid and Biochemical Indicator Status

Groups	TG	TC	LDL-C	HDL-C	AST	ALT	CRP	DAO	SOD
Treatment Group	1.55±0.13	5.01±0.56	3.03±0.24	1.58±0.17	32.70±5.99	34.43±4.59	6.87±0.91	10.19±0.73	89.75±6.11
Control Group	1.83±0.14	6.14±0.47	3.60±0.14	1.60±0.16	31.79±5.94	32.97±4.04	7.05±0.85	10.22±1.00	87.16±4.72
P	＜0.01	＜0.01	＜0.01	0.596	0.495	0.136	0.348	0.890	＜0.05

3.1.3 Comparison of pre and post-intervention blood lipids and biochemical indicators in patients

The results of pre and post-intervention blood lipids and biochemical indicators in patients revealed that in the treatment group, post-intervention levels of TG, TC, LDL-C, CRP, and DAO all significantly decreased (P<0.05), while HDL-C, AST, ALT, and SOD all significantly increased (P<0.05). In the control group, post-intervention levels of TG, TC, LDL-C, and CRP all significantly decreased (P<0.05), whereas HDL-C, ALT, and SOD all significantly increased (P<0.05). Specific details are outlined in Table 2.

Table 2. Pre and Post-intervention Blood Lipids and Biochemical Indicators

Status	Treatment group									Control Group								
	TG	TC	LDL-C	HDL-C	AST	ALT	CRP	DAO	SOD	TG	TC	LDL-C	HDL-C	AST	ALT	CRP	DAO	SOD
Pre-intervention	2.37±0.35	7.18±1.02	3.98±0.59	0.84±0.10	29.81±6.12	27.00±4.67	15.03±1.36	10.97±1.14	69.25±6.55	2.52±0.37	7.10±0.96	4.04±0.56	0.85±0.11	29.98±5.60	27.79±4.45	14.95±1.86	10.81±1.09	69.05±5.85
Post-intervention	1.55±0.13	5.01±0.56	3.03±0.24	1.58±0.17	32.70±5.99	34.43±4.59	6.87±0.91	10.19±0.73	89.75±6.11	1.83±0.14	6.14±0.47	3.60±0.14	1.60±0.16	31.79±5.94	32.97±4.04	7.05±0.85	10.22±1.00	87.16±4.72
P	＜0.01	＜0.01	＜0.01	＜0.01	＜0.05	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	0.112	＜0.01	＜0.01	＜0.05	＜0.01

3.2 Comparison of Inflammatory and Immune Response Indicators in Patients

3.2.1 Comparison of pre-intervention inflammatory and immune response indicators in two patient groups

The comparison of pre-intervention inflammatory and immune response indicators revealed no statistically significant differences between the two patient groups (P>0.05). Specific details are illustrated in Figure 2.

3.2.2 Comparison of post-intervention inflammatory and immune response indicators in two patient groups

The comparison of post-intervention inflammatory and immune response indicators revealed that in the treatment group, levels of TLR4 and MCP-1 were significantly lower than those in the control group (P<0.05). Detailed results are outlined in Table 3.

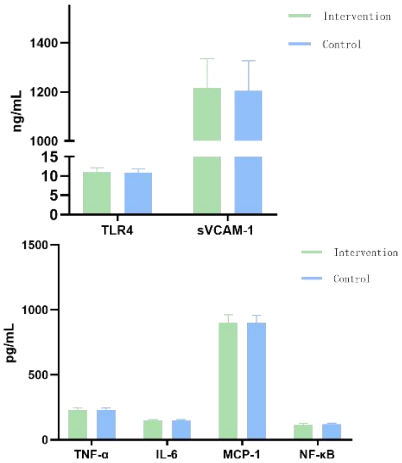

Figure 2. Levels of Inflammatory and Immune Response

3.2.3 Comparison of pre- and post-intervention inflammatory and immune response indicators in patients

The comparison of pre- and post-intervention inflammatory and immune response indicators revealed that in the treatment group, levels of TLR4, TNF-α, IL-6, MCP-1, sVCAM-1, and NF-κB significantly decreased post-intervention (P<0.05). Similarly, in the control group, post-intervention levels of TLR4, TNF-α, IL-6, MCP-1, sVCAM-1, and NF-κB exhibited significant reductions (P<0.05). Detailed results can be found in Table 4.

Table 3 Status of Post-intervention Inflammatory and Immune Response Indicators

Groups	TLR4	TNF-α	IL-6	MCP-1	sVCAM-1	NF-κB
Treatment Group	8.64±1.55	171.54±10.97	120.29±5.11	818.53±59.17	1059.49±99.78	103.92±8.24
Control Group	9.26±1.08	170.76±11.84	118.86±3.83	846.56±51.97	1049.10±91.12	104.58±8.90
P	＜0.05	0.760	0.160	＜0.05	0.628	0.743

Table 4. Status of Pre- and Post-intervention Inflammatory and Immune Response Indicators

Status	Treatment Group						Control Group					
	TLR4	TNF-α	IL-6	MCP-1	sVCAM-1	NF-κB	TLR4	TNF-α	IL-6	MCP-1	sVCAM-1	NF-κB
Pre-intervention	10.97±1.15	228.95±16.49	150.89±4.19	901.51±60.13	1218.38±117.45	118.30±8.53	10.83±1.03	227.49±16.40	150.99±4.64	900.22±58.72	1204.59±122.57	119.84±8.80
Post-intervention	9.26±1.08	171.54±10.97	120.29±5.11	846.56±51.97	1059.49±99.78	103.92±8.24	8.64±1.55	170.76±11.84	118.86±3.83	818.53±59.17	1049.10±91.12	104.58±8.90
P	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01	＜0.01

3.3 Comparison of TCM Symptom Scores Among Patients

3.3.1 Comparison of TCM symptom scores among patients

The comparison of TCM symptom scores revealed no significant difference in pre-intervention scores between the two groups (P>0.05). However, post-intervention, the treatment group exhibited significantly lower scores compared to the control group (P<0.05). Within the treatment group, post-intervention scores were significantly lower than pre-intervention scores (P<0.05); similarly, within the control group, post-intervention scores were significantly lower than pre-intervention scores (P<0.05). Specific results are outlined in Table 5.

Table 5. Status of TCM Symptom Scores

Groups	Pre-intervention	Post-intervention	P
Treatment group	19.53±7.03	8.93±4.60	<0.01
Control Group	21.05±7.04	12.00±5.27	<0.01
P	0.336	0.007	

3.3.2 Comparison of the therapeutic effect of Nimodipine in patients

The therapeutic effects of Nimodipine therapy in patients are as follows: in the treatment group, there was one case of inefficacy, 31 cases of effectiveness, 7 cases of significant improvement, and 1 case of cure. In comparison, the control group had 2 cases of inefficacy, 36 cases of effectiveness, 1 case of significant improvement, and 1 case of cure. The distribution between the groups showed statistical significance (P<0.05), with the treatment group having a total of 39 individuals who were either effective, significantly improved, or cured, surpassing the 38 individuals in the control group. Specific results are detailed in Table 6.

Table 6. Therapeutic Effect of Nimodipine

Groups	(n,%) Inefficacy (n,%)	(n,%) Effectiveness (n,%)	(n,%) Significant Improvement (n,%)	(n,%) Cure (n,%)
Treatment group	1(2.50)	31(77.50)	7(17.50)	1(2.50)
Control Group	2(5.00)	36(90.00)	1(2.50)	1(2.50)
P	<0.001			

4. Discussion

Hyperlipidemia, as a core pathological link in metabolic syndrome, is closely associated with chronic inflammation, oxidative stress, and immune dysregulation[7]. This study, by comparing the efficacy of Huazhuo Jiangzhi Tea with atorvastatin calcium tablets, has unveiled the unique advantages of TCM in regulating lipid metabolism and inflammatory pathways. TCM theory categorizes hyperlipidemia as “phlegm-dampness” and “blood stasis”, attributing the core pathogenesis of damp-heat internal blockage syndrome to spleen-stomach dysfunction and liver-qi stagnation, aligning closely with pathological features in modern

medicine such as lipid peroxidation and activation of inflammatory factors[8]. The Huazhuo Jiangzhi Tea utilized in this study consists of Crataegus pinnatifida, Gynostemma pentaphyllum, and Cassia obtusifolia. Crataegus pinnatifida inhibits key cholesterol synthesis enzyme (HMG-CoA reductase) activity through its flavonoid components, similar to statin drugs but in a milder manner[9]. Gynostemma pentaphyllum is rich in saponins, which can regulate lipoprotein metabolism and inhibit inflammation mediated by the TLR4/NF-κB pathway[10, 11]. Cassia obtusifolia, through its anthraquinone components, promotes bile acid excretion, reduces intestinal lipid absorption, and enhances the activity of the antioxidant enzyme SOD[12]. The synergy of these three herbs embodies the principles of "clearing and cleansing damp-heat, dispelling stasis, and lowering turbidity", intervening in lipid metabolism and inflammatory responses through multiple targets, showcasing the characteristic of holistic regulation in TCM.

Analyzing the situation from a molecular standpoint, the TLR4/NF-κB pathway emerges as a pivotal player in the inflammatory responses linked to hyperlipidemia. When the body is in a state of hyperlipidemia, internal signals such as free fatty acids and oxidized low-density lipoproteins act as innate danger signals, capable of activating the TLR4 receptor. This activation sets off a cascade of events, with downstream MyD88-dependent signaling pathways coming into play. Ultimately, this results in the translocation of NF-κB into the nucleus, prompting the expression of pro-inflammatory factors like TNF-α, IL-6, and MCP-1[13]. These inflammatory mediators not only exacerbate damage to the endothelial cells in blood vessels but also contribute to the formation of atherosclerotic plaques by recruiting monocytes[14]. In the context of this study, it was observed that the Huazhuo Jiangzhi Tea significantly reduced the levels of TLR4, NF-κB, and MCP-1. The underlying mechanism driving these effects appears to involve a multifaceted approach to regulation: the saponins found in Gynostemma pentaphyllum impede receptor dimerization by obstructing the binding of TLR4 and MD-2 proteins[15]. Additionally, the flavonoids present in Crataegus pinnatifida inhibit the phosphorylation of IκB kinase, thereby reducing the translocation of the NF-κB p65 subunit to the nucleus[16]. Furthermore, Cassia obtusifolia enhances the activity of SOD, which aids in the elimination of reactive oxygen species, thus impeding the activation of NF-κB mediated by ROS[17, 18]. This multi-target intervention model not only mitigates systemic inflammation but also holds the potential to delay the progression of atherosclerosis by enhancing the vascular microenvironment.

Clinical data showed that Huazhuo Jiangzhi tea was superior to atorvastatin in the comprehensive regulation of blood lipid profile: TG, TC and LDL-C in the intervention group decreased more significantly ($P < 0.01$), and SOD activity increased (89.75 ± 6.11 vs. 87.16 ± 4.72, $P < 0.05$), indicating that it had both antioxidant and anti-inflammatory synergistic effects. In addition, the decrease in TCM syndrome scores (54.3 % in the intervention group vs.43.0 % in the control group) further confirmed the advantages of Chinese herbal compound in improving subjective symptoms, which may be related to its regulation of the function of the intestinal flora-immune axis [19, 20]. In terms of safety, there was no significant difference in liver and kidney function between the two groups, but there were no common adverse reactions such as myalgia in the Chinese medicine group, which provided the possibility for long-term medication. However, there are still limitations in this study: 80 cases of sample size and 4 weeks of treatment is difficult to assess long-term cardiovascular risk; the specific targets of TLR4 / NF-κB pathway need to be further verified by cell experiments. The synergistic mechanism of compound components remains to be further analyzed by metabolomics and other technologies.

In summary, Huazhuo Jiangzhi Tea improves the inflammatory microenvironment of hyperlipidemia by regulating the TLR4 / NF-κB pathway, reflecting the multi-component, multi-target and multi-pass of traditional Chinese medicine.

Acknowledgments

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References

[1] Wang Yongyan, Wang Qi. Internal Medicine

of Traditional Chinese Medicine. Beijing: People's Medical Publishing House, 2011.
[2] Li Dexin Basic Theory of Traditional Chinese Medicine. Beijing: People's Medical Publishing House, 2006.
[3] She Yiming, Hu Yonghui, Zhang Liye, et al. Research Progress on Lipid Regulation with Traditional Chinese Medicine. Chinese Traditional and Herbal Drugs, 2017, (17): 3636-3644
[4] Qin Jian, Feng Jinwu. Research Progress on the Treatment of Hyperlipidemia with Traditional Chinese Medicine. World Journal of Integrated Traditional and Western Medicine, 2016, (11): 1607-1609+1614..
[5] Wang J, Guo LL, Wang YY. [Study on combination components and effectiveness of Chinese traditional herbal formulas]. Zhongguo Zhong Yao Za Zhi. 2006 Jan;31(1):5-9.
[6] Zhu Junren, Gao Runlin, Zhao Shuiping, et al. Guidelines for the Prevention and Treatment of Dyslipidemia in Chinese Adults (Revised Edition 2016). Chinese Circulation Journal, 2016, (10): 937-953.
[7] Wang Zhenmin, Luo Jianquan, Zhang Wei. Research Progress on the Correlation between LRP6 Gene Polymorphism and Metabolic Syndrome. Chinese Pharmacological Bulletin, 2016, (05): 603-607..
[8] Li Jianchao, Jiang Shengnan, Wu Jiahui, et al. Research Progress of Traditional Chinese Medicine in the Treatment of Hyperlipidemia. China's Naturopathy, 2024, (23): 100-103.
[9] Liang Hao, Li Yonghua, Zhao Na, et al. Research progress on the Lipid-lowering Mechanism of Active Components in Hawthorn. Jiangsu Journal of Traditional Chinese Medicine: 1-4.
[10] Wang N., Li C., Zhang Z. Arctigenin ameliorates high-fat diet-induced metabolic disorders by reshaping gut microbiota and modulating GPR/HDAC3 and TLR4/NF-κB pathways. Phytomedicine : international journal of phytotherapy and phytopharmacology, 2024, 135: 156123.
[11] Li Li, Huang Minjiang, Lu Xiaomin, et al. Research Progress of Gynostemma Pentaphyllum and its Active Components in the Treatment of Cardiovascular Diseases. RENSHEN YANJIU, 2025, (01): 77-80.
[12] Yuan Youcai, Li Liheng, Li Yan, et al. Research Progress on Chemical Components and Pharmacological Effects of Cassia Seed. Journal of Liaoning University of Traditional Chinese Medicine: 1-16.
[13] Hotamisligil G.S. Inflammation, metaflammation and immunometabolic disorders. Nature, 2017, 542(7640): 177-185.
[14] Libby P., Ridker P.M., Hansson G.K. Inflammation in atherosclerosis: from pathophysiology to practice. Journal of the American College of Cardiology, 2009, 54(23): 2129-2138.
[15] Lee B, Shim I, Lee H, Hahm DH. Gypenosides attenuate lipopolysaccharide-induced neuroinflammation and anxiety-like behaviors in rats. Anim Cells Syst (Seoul). 2018 Sep 5;22(5):305-316. doi: 10.1080/19768354.2018.1517825.
[16] Dong Hao, Ku Yabei, Wang Weipeng, et al. Research progress on Extraction Methods and pharmacological Effects of Total Flavonoids from Hawthorn. Studies of Trace Elements and Health, 2025, (01): 66-70.
[17] Ma Yong, Zhao Bin, Wang Minggang, et al. Anthraquinone glycosides of Cassia seed inhibit myocardial injury in rats with coronary heart disease through the Nrf2/ARE signaling pathway. hinese Journal of Histochemistry and Cytochemistry, 2022, (06): 565-574.
[18] Yen GC, Chung DY. Antioxidant effects of extracts from Cassia tora L. prepared under different degrees of roasting on the oxidative damage to biomolecules. J Agric Food Chem. 1999 Apr;47(4):1326-32. doi: 10.1021/jf9810618.
[19] Witkowski M., Weeks T.L., Hazen S.L. Gut Microbiota and Cardiovascular Disease. Circulation research, 2020, 127(4): 553-570.
[20] Li H.Y., Zhou D.D., Gan R.Y. et al. Effects and Mechanisms of Probiotics, Prebiotics, Synbiotics, and Postbiotics on Metabolic Diseases Targeting Gut Microbiota: A Narrative Review. Nutrients, 2021, 13(9):

