Research Process of Chia Seeds in the Fight Against Cardiovascular Inflammation

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Abstract. Chia seeds have gained attention in recent years as a nutrient-rich superfood. Its rich content of protein, fibre, antioxidants and omega-3 fatty acids are all known to be useful in the treatment of inflammation. Cardiovascular disease is an important problem of chronic disease, and due to cardiovascular disease leads to inflammation and thus damage to the human organism, and through the treatment of chemical drugs are prone to side effects on the organism, causing adverse reactions. This paper analyses the study of chia seeds as well as cardiovascular disease in these two aspects of the study, and after the results of the study showed that the omega-3 fatty acids in chia seeds have anti-inflammatory effects, and can reduce the incidence of occurrence of cardiovascular inflammation. In addition, antioxidants in chia seeds were able to reduce vascular damage and atherosclerosis. The combined findings suggest that chia seeds have a role in cardiovascular inflammation and that their nutrient-rich content has a positive impact on cardiovascular health. However, further studies are still needed to verify its specific mechanism of action and clinical application prospects. It is hoped that this paper can provide some reference for further research on the application of chia seeds in the therapeutic field of cardiovascular inflammation.

Keywords: Chia seeds, inflammatory, cardiovascular disease.

1. Introduction

Inflammation represents both a multifaceted reaction and the body's most frequent physiological response. The immune system frequently reacts to injuries, infections, or other unusual situations with inflammation. Inflammation refers to the body's general immune reaction, a defensive action taken in response to injury, infection, or various other triggers. This serves as a safeguarding system aimed at mending injured tissues and reinstating bodily functions. While inflammation plays a crucial role in bodily protection, an overabundance or extended duration of inflammatory reactions can result in multiple illnesses. Inflammation is a significant factor in various illnesses, such as rheumatoid arthritis, inflammatory bowel disease, cardiovascular disease, and specific cancers. The China Health Statistics Yearbook 2021 [1] indicates that in 2020, the death rates from CVD will continue to be the highest, surpassing those from cancers and other illnesses. From 2009 onwards, the death rate from CVD in rural areas has surpassed and consistently stayed above that in urban regions. By 2020, the death rate from CVD in rural areas is projected to reach 336.13 per 100,000, in contrast to 291.04 per 100,000 in urban areas, with CVD emerging as the leading cause of mortality in both rural and urban populations.

Chia seeds, abundant in protein, n-3 polyunsaturated fatty acids, soluble dietary fiber, antioxidants, and various nutrients, are effective in reducing blood pressure and lipids, lowering blood sugar, and other health advantages [2]. Chia seeds are rich in omega 3 and omega 6 fatty acids, advantageous for health. Research has shown that macrophages exposed to chia seed-derived adipocyte-conditioned medium can suppress inflammatory cytokines linked to the brain, coronary arteries, and lower limb arterial blood vessels, including PAI-1, MCP-1, PGE-2, and TLR-4 [3]. These fatty acids transform into precursors of inflammatory agents, influencing the intensity of the inflammatory reaction. Furthermore, the dissolvable dietary fiber found in chia seeds plays a role in controlling gastrointestinal activities and enhancing gut flora, aiding in the equilibrium of gut flora and thereby impacting immune system regulation.

Presently, the primary treatment for inflammation involves the use of pharmaceuticals. The goal of pharmacological treatments is to disrupt the sequence of inflammation, immune suppression, and proteolytic metabolism [4]. Yet, the majority are drugs that continue to cause bodily side effects, including negative digestive responses, heart rhythm disorders like irregular, slow, or rapid heartbeat, muscle aches, frailty, or muscle harm. When researching inflammation, utilizing plant-based sources can lessen the adverse effects of various chemicals, as plants are abundant in nutrients and bioactive substances with anti-inflammatory and immune-modulating capabilities.

Recent studies have explored the anti-inflammatory properties of chia seeds, yet the specific impact of these seeds on heart-related illnesses and their influence on different human body markers remains largely undefined. Consequently, this paper primarily sought to delve deeper into how chia seeds contribute to cardiovascular inflammation by inducing inflammation, identifying the particular chemicals present in chia seeds, and assessing their possible effectiveness in treating cardiovascular inflammation.

2. The Importance of Cardiovascular Inflammation

2.1. Atherosclerosis

This long-term inflammatory condition involves cardiovascular inflammation, a major factor in atherosclerosis development. Inflammation frequently underpins both physiological and pathological shifts in atherosclerosis' emergence and advancement. At the core of cardiovascular disease's development lies atherosclerosis, characterized by plaque rupture, platelet clumping, and thrombosis, culminating in vascular stenosis or blockage, which in turn leads to acute cardiovascular disease [5]. Such inflammatory responses in the arterial wall can lead to vascular endothelial harm and the invasion of inflammatory cells, thereby fostering the development of atherosclerotic plaques.

2.2. Myocardial Infarction

Myocardial infarction (MI) manifests as a pathological state where the death of cardiomyocytes occurs due to blocked blood flow to the myocardium, typically caused by a coronary artery blockage. The extent of inflammation plays a crucial role in the severity of myocardial infarction and the ensuing changes and functioning of the heart [6]. Obstruction in a coronary artery leads to myocardial ischemia and hypoxia, initiating an inflammatory reaction. The infiltration of inflammatory cells and the emission of inflammatory agents result in the damage and necrosis of myocardial cells, enlarging the myocardial infarction area and causing permanent impacts on myocardial performance.

2.3. Cardiac Failure

Inflammatory reactions may result in conditions like myocardial fibrosis, myocardial hypertrophy, and cardiac remodeling, potentially diminishing both systolic and diastolic cardiac functions. Inflammation of the cardiovascular system may additionally deteriorate heart performance via processes influencing calcium balance and cell death in heart muscle cells. It's acknowledged that systemic inflammation is a shared pathological characteristic in both acute and chronic heart failure (HF) [7].

2.4. Signs Pertaining to Cardiovascular Disease

Blood pressure levels, both systolic and diastolic: Elevated blood pressure significantly increases the risk of heart-related diseases. Persistent high blood pressure may result in the onset of atherosclerosis and inflammation of the heart. Inflammation of the cardiovascular system can lead to hypertension by harming the vascular endothelium and fostering the development of atherosclerotic plaques.

Total Cholesterol and low-density lipoprotein cholesterol (LDL-C): High levels of total cholesterol and LDL-C are associated with an increased risk of cardiovascular disease. These lipid abnormalities can lead to the formation of atherosclerosis, which increases the risk of cardiovascular inflammation.

Triglyceride (TG) Concentration: High triglyceride levels are strongly associated with the development of cardiovascular disease. High triglyceride levels may contribute to the formation of atherosclerosis and are associated with the development of cardiovascular inflammation.

High-density lipoprotein cholesterol (HDL-C): HDL-C is considered the "good" cholesterol, and its levels are negatively correlated with the risk of cardiovascular disease. HDL-C is anti-inflammatory and may reduce cardiovascular inflammation by reducing inflammation in the arterial endothelium and by facilitating the reverse transport of cholesterol.

Due to the multiple etiologies involved in cardiovascular disease, it is not possible to use a separate anti-inflammatory drug regimen to control inflammation and alleviate cardiovascular disease. As a result, it would be advantageous to start anti-inflammatory medication early in the course of cardiovascular disease to balance the healing process [8].

3. Chia Seed's Chemical Composition and Nutritional Characteristics

3.1. Chia Seed Active Ingredients and Description

The nutritional composition and content of chia seeds are shown in Table 1. Chia seeds are a nutrient-rich food with active ingredients that are beneficial to human health; Omega-3 fatty acids are essential for cardiovascular health, dietary fibre aids in digestion and blood sugar control, proteins are important building blocks of body tissues, antioxidants are beneficial in combating oxidative stress, and minerals play a key role in several physiological processes. Thus, chia seeds, as a nutrient-dense food, can be an important addition to diet.

Table 1. Chia Seed Active Ingredient Content and Description

Ingredients	Content	Description
Protein	18-23%	Chia seeds are a high quality source of plant protein that helps to provide the body with the nutrients it needs to support the normal functioning of the immune system.
Unsaturated fatty acids	Linolenic acid (n-3 fatty acids), linoleic acid (n-6 fatty acids): about 60 percent of all fatty acids [2].	Supplementing with linoleic acid and α linolenic acid helps prevent and improve symptoms of growth retardation and dermatitis, as these fatty acids cannot be synthesized by the body. Linoleic and α-linolenic acids can prevent and treat cardiovascular disease, hypertension, rheumatoid arthritis, asthma, allergies, and suppress tumor growth.
Fibre	Soluble cellulose: 10% Insoluble cellulose: 90%	Chia seeds likely contain about 30 g of dietary fiber, [9]. Chia seeds have more nutritional fibre than dried fruits, cereals, and nuts [10]. These fibers contribute to intestinal health, promote digestion, and avoid constipation. Chia seeds are also high in polysaccharides, which
Polysaccharides	42.12g/100g	Polysaccharides are believed to help regulate blood sugar and improve immunological function.
Antioxidants	Vitamin C, Vitamin E and polyphenolic compounds	These compounds serve to neutralize free radicals, minimize oxidative stress, and protect cells from oxidative damage.
Fatty acids	Abundant glutamic acid: 123g/kg	Chia seeds contain 18 amino acids, of which 8 are essential and 10 non-essential. High-content amino

	Arginine: 80.6 g/kg Aspartic acid: 61.3g/kg	acids include glutamic acid and aspartic acid, alanine, serine, and glycine [11].

3.2. Anti-inflammatory Mechanism of Chia Seeds

Rich in Linolenic Acid: Chia seeds are rich in Omega-3 fatty acids. Linolenic acid can be converted in the body into a series of metabolites with anti-inflammatory effects These metabolites can inhibit the occurrence and development of inflammatory reactions, reducing the degree of inflammation in cardiovascular tissue.

Antioxidant effects: Chia seeds are rich in antioxidants such as vitamin C, vitamin E and polyphenolic compounds. These antioxidants can neutralise free radicals and reduce the damage to cardiovascular tissues caused by oxidative stress. Oxidative stress is an important driver of the inflammatory response, and by reducing oxidative stress, chia seeds are able to reduce cardiovascular inflammation.

Dietary Fibre: Chia seeds are rich in both soluble and insoluble fibre, which can exert anti-inflammatory effects through a number of mechanisms. Soluble fibre binds to water to form a gelatinous substance that slows the passage of food through the digestive tract, reducing the insulin response and the release of inflammatory mediators. Insoluble fibre promotes intestinal peristalsis and reduces the amount of time harmful substances remain in the intestines, thus reducing inflammation.

Protein and Amino Acids: Chia seeds are rich in high quality protein and many essential amino acids. Protein and amino acids are important components of tissue repair and immune regulation. By providing sufficient protein and amino acids, chia seeds can enhance the function of the immune system and inhibit inflammatory responses.

4. Chia Seeds in Cardiovascular Inflammation

4.1. Antioxidant Activity of Chia Seeds

The antioxidant properties of chia seeds are remarkable, owing to their elevated levels of phenolic acid, flavonoids, and vitamins [2]. The main components of it are phenolic acids and diverse polyphenolic substances like flavonoids. Antioxidants like vitamin C, vitamin E, and polyphenolic compounds are found in chia seeds. Furthermore, novel antioxidants, including flavonoid glycosides, have been identified. These compounds aid in counteracting free radicals, diminishing oxidative stress, and lessening the regularity and severity of inflammatory reactions. Additionally, chia seeds boost both immune response and resistance. Zhijun Xiao's experiments with associates [12] reveal that CPS-A in chia seeds enhances their capacity to eliminate free radicals as concentration rises. CSP, a polysaccharide found in chia seeds, exhibits specific antioxidant properties. Evidence suggests that CSP-A has a moderate effect on macrophages, prompting them to release pro-inflammatory agents, interleukins, and various substances. Conversely, in the control group without CSP-A, cytokines like interleukins and different amounts of small were secreted, as evidenced by the comparison between the experimental and control groups, confirming CSP-A's role in cellular immune regulation.

4.2. Cardiovascular Protection Effect of Chia Seeds

Vladimir and his team's research [13] revealed that prolonged consumption of chia seeds in individuals with diabetes markedly lowers various risk factors for cardiovascular diseases. In this single-blind study, participants were randomly selected to be administered 37 +/- 4 grams of chia seeds daily over a period of 12 weeks. The study involved 11 males and 9 females. Experimental findings indicate a link between chia seeds and reduced systolic blood pressure, along with heightened sensitivity of c-reactive protein, without altering safety measures. Consequently, it's demonstrable that consistent consumption of chia seeds can significantly lower cardiovascular disease risks.

However, given that the 20 participants were diabetic, it remains uncertain if chia seeds' impact on healthy individuals' mirrors that on diabetic patients in the study.

Sierra and his group [14] administered chia seed oil as a nutritional treatment to 32 male rabbits suffering from hypercholesterolaemia over a period of 5-6 weeks. Rabbits received a daily addition of 10% chia seed oil to their diet, followed by random allocation into four distinct groups, each housed separately in cages subjected to varying temperatures, humidity, and sunlight, following a 12-hour cycle. Introducing chia seed oil into this study elevated ALA levels in rabbits, while adding chia seed oil to their diet reduced their contractile reaction to norepinephrine. The results indicate that elevating ALA levels due to chia seed oil consumption may enhance blood vessel health in animals with hypercholesterolemia, leading to better heart health in these animals. Nonetheless, since the study's participants were rabbits, not humans, there's no absolute assurance that chia seeds will be as beneficial in humans as in rabbits.

4.3. Effect of Chia Seeds on Indicators Related to Cardiovascular Disease

In a different study, Omid Nikpayam and colleagues explored the impact of adding chia seeds on body measurements and metabolic aspects by assessing the [15], aiming to ascertain if chia seeds positively influence the human body. To explore the impact of chia seed products on body measurements, blood pressure, glucose levels, lipids, and inflammation markers, 729 individuals and 14 experimental groups were conducted. Throughout the 14 studies, adding chia seed products markedly decreased systolic and diastolic blood pressure, overall cholesterol, LDL cholesterol, HDL cholesterol, and triglycerides, while the fiber and Omega-3 fatty acids in chia seeds might aid in reducing total cholesterol and LDL cholesterol levels. Nonetheless, the full efficacy of chia seed products might necessitate extended durations and greater dosages, and it often takes a considerable amount of time for them to completely manifest their benefits and be effectively used.

5. Conclusion

Chia seeds have a very long history of consumption and are rich in high quality protein, Omega-3 polyunsaturated fatty acids, soluble dietary fibre, vitamins, minerals and a variety of antioxidant compounds, which have the ability to regulate blood lipids, regulate blood glucose, regulate blood pressure, assist in weight loss, and prevent cardiovascular disease. Comprehensively analysing the results of current studies, chia seeds show potential modulating effects on cardiovascular inflammation. Anti-inflammatory effects: Chia seeds are rich in a variety of bioactive components, such as linolenic acid, cellulose and antioxidants, with anti-inflammatory effects. These components can inhibit the production of inflammatory factors and reduce the inflammatory response of cardiovascular tissue. Antioxidant effects: The antioxidants in chia seeds neutralise free radicals and reduce damage to cardiovascular tissues caused by oxidative stress. This antioxidant effect helps to reduce the level of inflammation and protects the health of the cardiovascular system. Lipid regulation: Chia seeds are rich in Omega-3 fatty acids that help regulate blood lipid levels, lowering cholesterol and triacylglycerol levels. This is important for the prevention of atherosclerosis and cardiovascular disease.

Based on current research results, the modulating effect of chia seeds on cardiovascular inflammation has been tentatively confirmed. However, there are still some issues that need to be further researched and resolved. The following are the directions for future research:

1) Mechanistic studies: To further understand the mechanism of action of chia seeds on cardiovascular inflammation, including the signalling pathway at the molecular level and the mode of action of bioactive components.

2) Clinical application: Evaluate the efficacy and safety of chia seeds in the treatment of cardiovascular inflammation by conducting more clinical studies. In addition, there is relatively little information from larger epidemiological surveys and data from human trials.

3) Dosage and Administration: To determine the optimal dosage and administration of chia seeds for better modulation of cardiovascular inflammation. In-depth and systematic research on the efficacy, composition and mechanism of health care functions of chia seeds can provide a scientific basis for the development and utilisation of chia seeds.

4) Combination with other interventions: Research on the combination of chia seeds with other drugs or interventions to explore more effective strategies for the treatment of cardiovascular inflammation.

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