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The Effect of Chia Seeds (Salvia hispanica L.) Consumption on Health: A Literature Review

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Abstract

Background. Chia (Salvia hispanica) is a plant species native to Mexico and Guatemala. Chia seeds possess significant nutritional properties, as they contain a high amount of antioxidants, as well as minerals valuable for human health and vitamins E, B1, and B3. Chia seed oil contains a very high concentration of omega-3 fatty acids. Due to their high nutritional value, chia seeds are recommended for inclusion in the daily diet of both adults and children.

Methodology. A review was conducted using PubMed. Search terms included: chia seeds, salvia hispanica, omega-3 acids, alpha-linolenic acid. Studies published between 2019 and 2025 were reviewed.

Results. Chia seeds (Salvia hispanica) are highly nutritious, due to their high dietary fiber content (approx. 30–35%), which has a beneficial effect on intestinal motility and glucose metabolism. They are a rich source of α-linolenic acid (ALA) from the omega-3 group, which exhibits cardioprotective effects, positively influences the lipid profile, and reduces the risk of cardiovascular diseases, as well as being a very important component of neuronal membranes, crucial for the development of the nervous system. Chia seeds also provide significant amounts of minerals, particularly calcium, magnesium, phosphorus, and iron, which may support the functioning of the skeletal and enzymatic systems. The presence of phenolic compounds and other antioxidants contributes to the reduction of oxidative stress and may have anti-inflammatory effects.

Conclusions. Salvia hispanica offers broad therapeutic potential in nutrition and preventive potential in medicine in particular in children, for whom an adequate intake of omega-3 fatty acids is crucial due to the rapid development of their nervous system, as well as the development of the heart and circulatory system. Chia has cardioprotective, neuroprotective, and anti-inflammatory properties and has a positive effect on intestinal function.
Keywords: chia seeds, chia seeds oil, omega-3, supplement**,** health, diet

Introduction

Salvia hispanica (Chia) belongs to the mint family (Lamiaceae). Its seeds are egg-shaped, gray with black and white specks, and measure about 2 millimeters (0.08 inches). It has become increasingly popular in recent years among health-conscious consumers, mainly due to their high content of omega-3 fatty acids, which offer numerous health benefits. Comprehensive chemical analyses of the fatty acids and proteins in chia seeds were conducted, confirming the presence of large amounts of nutraceutical compounds with significant health benefits, including omega-3 polyunsaturated fatty acids, proteins, and phenolic compounds with antioxidant properties [1,4].

The available scientific literature points to the significant cardioprotective, blood pressure-lowering, antidiabetic, and antiatherosclerotic effects of this raw material; it also exhibits neuroprotective, hepatoprotective, and anti-inflammatory properties, as indicated by the results of studies based on in vitro tests and animal models such as rats. The mentioned reports provide evidence of the valuable role of chia seeds in the prevention of lifestyle-related diseases [2].

Materials and methods

A review of the literature was conducted to summarize the current state of knowledge on the health effects of chia seeds (*Salvia hispanica* L.). A systematic search of the PubMed database was performed using the following keywords: *"chia seeds," "Salvia hispanica," "omega-3 acids," "alpha-linolenic acid"*. Publications from January 2019 to January 2025 were considered.

DISCUSSION

Nutritional Compounds and Historical Background

Chia (Salvia hispanica L.) is a herbaceous plant, originally from southern Mexico and northern Guatemala. The genus Salvia comprises approximately 900 species, which have been widely cultivated for thousands of years in various regions of the world, including Southern Africa, Central America, North and South America, and Southeast Asia. The word "chia" comes from Spanish and literally means "oily." The scientific name Salvia hispanica was given to it by Carl Linnaeus. Although it may seem that chia seeds are a relatively new food product on the market, they have been a very important food source for a long time—for example, for the Aztecs in pre-Columbian times—and the flour made from them, known as chianpinolli, has been widely used ever since to make beverages and tortillas. Archaeological evidence indicates that chia seed oil was used not only as a food product but also in art and for the production of varnishes and cosmetics. In the 18th and 19th centuries, chia seeds began to be added to lemonades, resulting in the popular refreshing drink known as "chia fresca." The plant also found therapeutic applications in medicine; for example, in Mexico and Central America, chia seeds were used as an ingredient in infusions for treating skin injuries, as well as an adjunct in gastrointestinal disorders and respiratory diseases. Chia was also cultivated by the peoples of Mesopotamia for therapeutic and medicinal purposes, but then disappeared from use for centuries, until the mid-20th century, when it was rediscovered. Nowadays the plant is grown all over the world [1,3,10]. Chia seeds began to be marketed in European countries in 2009 after they had been officially authorized. Since then, its consumption has been growing year by year, and in 2018, Germany was the leading consumer and importer of chia seeds for food use. [12,17].

In recent years, there has been growing interest in healthy eating, which has led to increased demand for plant-based products with health-promoting properties. Chia seeds, as a widely available product, are a popular choice due to their high nutritional and functional value and high content of polyunsaturated fatty acids (PUFAs), primarily omega-3 fatty acids, as well as plant protein, dietary fiber, and proteins which contain 42–43 % of essential amino acids, such as histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. These crucial nutrients are not synthesized by the human body and must therefore be obtained through a balanced diet. Chia seeds are a rich source of vitamins such as Vitamin B1, Vitamin B2, and Niacin as well as many minerals such as potassium, magnesium, calcium, and phosphorus. It should be emphasized, however, that the nutritional composition of chia seeds

is not constant, as it can vary depending on the influence of many external factors, such as climate, geographical location, the properties of the soil in which the seeds grow, altitude, and even the year of cultivation. Another advantage of chia seeds is that they are gluten-free [3,10,15].

Antioxidant Effects and Anti-inflammatory Effects

Inflammatory disorders and oxidative stress are recognized as key factors in the modulation of these processes; polyunsaturated fatty acids (PUFAs) play a particularly important role in this regard, as they influence antioxidant response pathways and, by affecting hepatic lipid metabolism, also shape the physiological responses of the heart muscle. Observations from long-term prospective studies demonstrate that maintaining an optimal intake of linoleic acid (omega-6) supports the prevention of cardiovascular disease (CVD), likely by lowering blood lipid levels. Importantly from a clinical perspective, current evidence does not indicate prothrombotic or pro-inflammatory properties of arachidonic acid at a daily intake of up to 1,500 mg; no immunosuppression is observed, while this substance may support the functioning of the nervous and muscular systems. In the context of general prevention of inflammatory diseases (including CVD), the literature extensively confirms the beneficial profile of higher doses of omega-3 fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Regular consumption of chia seeds ensures an adequate intake of omega-3 fatty acids in the diet, which offers numerous benefits in terms of preventing and supporting the treatment of autoimmune diseases. This has been demonstrated in diseases such as rheumatoid arthritis and systemic lupus erythematosus—an adequate intake of the polyunsaturated fatty acids found in chia seeds may help reduce the risk of developing these conditions in healthy individuals, and in patients with the aforementioned conditions, may lead to an improvement in inflammatory biomarkers and disease activity, leading toward remission [8,16].

Chia seeds are a widely available and easy-to-prepare food rich in phenolic compounds, including rosmarinic acid, protocatechuic acid, myricetin, quercetin, citric acid, quinic acid, and choline. A diet rich in antioxidants has long-term health benefits, as it reduces the risk of degenerative, neurodegenerative, and cancerous diseases by neutralizing free radicals. Moreover, lipid metabolites of omega-3 fatty acids reduce inflammation and promote homeostasis [3,5].

Neuroprotection and Support in Metabolic Disorders

Chia seeds are a widely available source of essential amino acids, which are crucial to maintain neuronal and cognitive functions, balance the levels of serotonin (a neurotransmitter that regulates appetite, mood and sleep). The importance of ensuring an adequate intake of omega-3 fatty acids in the diet is also a major focus of research in the field of mental health, particularly in the context of the prevention and treatment of depressive disorders. Scientific reports indicate that omega-3 fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), may exhibit antidepressant effects attributable to their influence on the modulation of neuroinflammation, neurotransmitter function, and increased neuroplasticity of the central nervous system and neurons. Of course, one cannot speak here of an independent role in the treatment of depression; the intake of these compounds and a healthy diet can only support pharmacological treatment [3,9]. A high intake of omega-3 fatty acids is statistically significantly associated with a lower risk of developing neurodegenerative and dementia-related diseases; the disease most frequently cited in studies is Alzheimer's disease, as demonstrated in a study that analyzed this risk in individuals supplementing with omega-3 compared to those not taking these supplements. Furthermore, individuals who used supplements for a long time had as much as a 64% lower risk of developing Alzheimer's disease compared to those who did not use them at all. Separate analyses showed that, compared to no intake, long-term, multi-year use of omega-3 supplements was particularly significantly associated with the risk of Alzheimer's disease in men, the elderly, APOE ε4 carriers, and patients with mild cognitive impairment [7]. The essential amino acids provided by chia seeds in diet assist in protein, hormone and enzyme biosynthesis and metabolism, all of which are crucial for human energy metabolism [3]. Alpha-linolenic acid, found in chia seeds, plays a key role in the production of certain biochemical compounds, such as leukotrienes and thromboxanes, which are involved in numerous physiological functions in the human body and are essential for proper metabolism. The study also demonstrated the contribution of chia seeds' nutrients to regulating body weight and possibly other comorbidities associated with diabetes [17].

However, they may have no effect when it comes to weight loss or on disease risk factors in overweight adults with elevated levels of inflammatory markers, hypertension, or body mass index [10]. Chia seeds are a suitable dietary substitute for fish, providing both omega-3 fatty acids and plant-based protein. The potential positive effects of polyunsaturated fatty acids in the diet stem primarily from their anti-inflammatory properties [16]. Furthermore, consuming

chia seeds in appropriate amounts during pregnancy supports the development of the retina and the central nervous system of the fetus; of course, it is important to maintain a generally healthy and varied diet and a healthy lifestyle [17].

The Effect on the Digestive System

Chia seeds are a product with an excellent nutritional profile, as they are a great source of polyunsaturated fatty acids, plant protein, dietary fiber, as well as micronutrients and macronutrients. However, their hard physical structure can cause these seeds to remain virtually intact during digestion and linger in the digestive tract, thereby preventing the release and absorption of the aforementioned nutrients they contain. An in vitro study was conducted to analyze the digestion of chia seeds under standard intestinal conditions (pH 7, bile salt concentration 10 mM) and subsequently under conditions modified for the purposes of comparative analysis (pH 6, bile salt concentration 1 mM). The analysis showed that the altered conditions significantly reduced lipolysis, while the proteolysis process did not differ significantly from proteolysis under standard digestion conditions [14]. The geographical origin and soil type where chia seeds are grown also had a significant impact on the soluble fiber content at the beginning and end of gastric and duodenal digestion [15].

Whole-grain and partially defatted flour, compared to chia seeds, increased the hydrolysis of lipids and proteins, which was associated with smaller particle sizes of these components. Calcium bioavailability was reduced in all of the tested samples under both standard and modified digestion conditions. It has also been shown that as the digestion of seeds proceeds in the human digestive tract, the bioavailability (the measure of how much of the ingested nutrient is ultimately absorbed from the digestive tract and enters the bloodstream) of polyphenols in all seed structures increases, but antioxidant activity decreases, with one exception—the decrease in antioxidant activity does not apply to ground structures. In summary, in cases where the goal of consuming chia seeds is to increase the potential absorption of macro- and micronutrients, rather than merely their taste, it is advisable to grind the chia seeds before consumption, as this positively affects the bioavailability of their nutrients. Sprouting the seeds, on the other hand, improves the efficiency of digestion and protein absorption and reduces the lipolysis process. [14].

The Importance and Advantages of Chia Seeds in Diet

Since the 1980s, Europe has seen an exponential increase in the regular consumption of omega-3 fatty acids in the daily diet, which helps reduce the risk of many chronic diseases in humans, particularly cardiovascular, neuropsychiatric, and autoimmune conditions [16].

Thanks to their rich nutritional profile, chia seeds exhibit beneficial antioxidant, anti-inflammatory, antidepressant, memory-enhancing, antibacterial, anticoagulant, antiarrhythmic, and antidiabetic properties; they positively influence the development of the central nervous system and the visual system in the fetus, and also have hypotensive and immunostimulatory effects [20].

Chia seeds are an excellent source of protein for people following vegetarian diets, including children, because they contain essential amino acids. Chia seeds also serve as a useful supplement and a way to enrich the diet with plant-based protein and polyunsaturated fatty acids for people who are actively involved in sports, especially since they are widely available and very easy and quick to prepare. Due to their rich and nutritionally beneficial composition, it has been scientifically proven that chia seeds have a beneficial effect on slowing down the body's ageing process, reducing the risk of developing cardiovascular diseases, degenerative diseases, and neurodegenerative diseases, reducing obesity, as well as the incidence of diabetes and certain types of cancer, such as liver, pancreatic, colorectal, and breast cancer. Furthermore, regular consumption of chia seeds, combined with an overall healthy diet and lifestyle, is associated with lower triglyceride levels and blood pressure, as well as a reduction in waist circumference. Adding chia seeds to meals also helps reduce post-meal spikes in blood sugar level. All the above lower the risk of developing many lifestyle-related diseases such as hypertension, atherosclerosis, diabetes, and obesity [12,19].

Another benefit of chia seeds is their ability to form a gel-like consistency when mixed with water, due to their high mucilage content. This property improves the texture of various foods, such as yogurt or pudding. Furthermore, the seeds themselves are practically imperceptible when mixed with semi-liquid products like drinkable yogurt, making them easy for children to consume as well [13].

The Effect on Reducing the Risk of Cardiovascular Diseases

A balanced, nutrient-rich diet consisting of minimally processed foods is essential for maintaining the proper functioning of our internal organs and for preventing lifestyle-related diseases. Among the adult population, cardiovascular diseases—such as coronary artery disease—are undoubtedly one of the major health problems that can be significantly reduced

through lifestyle and dietary changes. Cardiovascular diseases refer to conditions that disrupt the functioning of the heart or blood vessels. They are typically associated with the build-up of atherosclerotic plaques on the inner walls of blood vessels and an increased risk of blood clots, largely influenced by an unhealthy lifestyle—insufficient physical activity and poor diet. In addition to limiting the consumption of processed foods and foods high in saturated fats and simple carbohydrates, it is also important for maintaining good health to ensure an adequate intake of polyunsaturated fatty acids—specifically, omega-3 fatty acids. Omega-3 fatty acids, such as EPA, may help reduce the risk of cardiovascular disease, reduce the risk of atherosclerosis, and prevent thromboembolic conditions through specialized molecules known as pro-resolving mediators, which, together with other anti-inflammatory mediators, can restore homeostasis following tissue damage [5]. Chia seeds contain a large amount of omega-3 fatty acids and antioxidants. Omega-3 fatty acid supplementation is often recommended for preventing cardiovascular diseases in patients with elevated triglyceride level. The omega-3 fatty acids found in chia seeds also help to reduce blood triglyceride levels, so that chia can be used as functional ingredients to help reduce the risk of cardiovascular disease and premature death. Furthermore, thanks to their nutritional profile, chia seeds help raise HDL cholesterol levels in the blood, which has a cardioprotective effect. Regular consumption of chia seeds helps reduce cardiovascular risk and, consequently, the risk of death from cardiovascular causes [4,6,18].

Safety and Toxicological Considerations

Chia is a relatively new food product that is exceptionally rich in nutrients with health-promoting properties. However, there are some concerns regarding the formation of processing contaminants as a result of heat treatment, which means that high consumption of chia seeds is not entirely without controversy. Studies were conducted to analyze acrylamide formation in chia seeds under various roasting conditions—at different temperatures and for varying durations—and to compare seeds in different forms (whole and ground) in this context. The results of the aforementioned studies showed that acrylamide content increases with the intensity of thermal processing, reaching a maximum at 180 °C/15 min. Acrylamide formed rapidly on the seed coat but accounted for only 20–25% of the total volume of a single chia seed. In food applications involving heat treatment and grinding, the particle size and integrity of chia seeds should be considered, or the addition of ground seeds should be revised to reduce consumer exposure to acrylamide which is classified as a potential carcinogen to humans [11]. Excessive consumption of chia seeds also exposes consumers to elements, some of which may

be potentially toxic, such as zinc (Zn), cadmium (Cd), and aluminum (Al). It is believed that the excessively high levels of these elements in the seeds result from soil contamination where salvia hispanica is grown [12].

Summary

Salvia hispanica L. is a plant species that has been cultivated and used for food and medicinal purposes since ancient times. In summary, the results indicate that a sustained intake of chia seeds which is rich in omega-3 fatty acids, shows potential for reducing the risk of carcinogenesis, cardiovascular diseases, autoimmune diseases such as rheumatoid arthritis or systemic lupus erythematosus, developing Alzheimer's disease, dementia, various other neurodegenerative diseases and general cognitive decline. Furthermore, it has been observed that peripheral biomarkers of omega-3 fatty acids may serve as useful predictors in assessing the risk of cognitive decline. However, a full understanding of the impact of omega-3 intake, particularly regarding significant genetic-environmental interactions, requires further detailed research. Another benefit of adding chia seeds to the diet is, of course, their high content of vitamins, micronutrients, macronutrients, and plant-based protein. In addition, when consumed in moderation, chia seeds—thanks to their high dietary fiber content—help maintain gut health and a balanced gut microbiota. [1,3,4,8,17].

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