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+15878858911
editorial-office@sciformat.ca

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CHIA SEEDS (*SALVIA HISPANICA L.*) AND THEIR IMPACT ON CARDIOVASCULAR, METABOLIC AND INFLAMMATORY DISEASES: A NARRATIVE REVIEW

Natalia Marzec (Corresponding Author, Email: marzecnatalia00@gmail.com)

Szpital św. Wojciecha, Gdańsk, Poland

ORCID ID: 0009-0008-4722-7321

Anna Roman

Faculty of Medicine, Medical University of Gdansk, Poland

ORCID ID: 0009-0008-7152-9880

Stanisław Wardęcki

Szpital Morski im. PCK, Gdynia, Poland

ORCID ID: 0009-0008-7703-490X

Weronika Praska

Szpital Morski im. PCK, Gdynia, Poland

ORCID ID: 0009-0004-1544-1404

Joanna Zajęczkowska

University Clinical Centre, Gdańsk, Poland

ORCID ID: 0009-0003-4912-9809

Natalia Domańska

University Clinical Centre, Gdańsk, Poland

ORCID ID: 0009-0008-6378-8903

Aleksandra Marzec

Szpital św. Wojciecha, Gdańsk, Poland

ORCID ID: 0009-0007-7885-948X

Natalia Krupa

Szpital Specjalistyczny w Kościerzynie, Kościerzyna, Poland

ORCID ID: 0009-0007-6691-0073

Dominika Galińska

University Clinical Centre, Gdańsk, Poland

ORCID ID: 0009-0004-8037-2679

Małgorzata Cherek

Szpital św. Wincenta a Paulo w Gdyni, Gdynia, Poland

ORCID ID: 0009-0007-4116-1854

ABSTRACT

Introduction: Chia seed is a part of the *Salvia hispanica* plant, which originates from Central and South America and is known for its high nutritional value. In recent years, chia seeds gained considerable attention due to their potential positive impact on human health, mainly associated with high concentrations of polyphenols and antioxidants, as well as dietary fiber, essential amino acids, polyunsaturated fatty acids, vitamins and minerals. The promising properties of chia seeds could be useful in managing cardiovascular, metabolic and inflammatory diseases, which makes them a subject of many experiments and studies.

Purpose: The aim of this review is to evaluate the current knowledge on chia seeds' impact on human health, focusing on cardiovascular and metabolic health as well as on their potential antioxidant properties.

Methods: A comprehensive review of literature was performed using electronic databases - PubMed and Google Scholar. Relevant articles from the past two decades were found, including randomized controlled trials, meta-analyses, case reports, opinions and review articles.

Results: The executed research suggests that the most distinct clinical effect of chia seed supplementation is visible in its ability to reduce blood pressure and increase omega-3 fatty acids levels, which suggests its cardiovascular-protective possibilities. There is also clinical evidence of their favorable impact on postprandial glycemic levels and anti-inflammatory and antioxidant effects, however, those findings are not consistently supported by all studies. The evidence of their influence on body weight and glycemic control is weak and rather inconclusive.

KEYWORDS

Chia Seeds, *Salvia Hispanica*, Cardiovascular Diseases, Glucose Metabolism, Inflammation

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1. Introduction

Chia seeds are edible elements of the *Salvia hispanica* plant. They have been used since ancient times - primarily in Central and South America by the Aztec and Mayan civilisations as an ingredient of food and medicine. Nowadays, chia seeds are gaining increasing attention due to emerging reports on their positive health impacts and extraordinary nutritional value. Driven by those reports, people began to regularly incorporate chia seeds into their diets. This is evident in the growing demand for chia seeds in the global food industry, which is estimated to be up to a 90 000 metric tons per year. [22]

The chemical composition of chia seeds is what justifies the demand for that crop. Chia seeds are a rich source of dietary fiber, essential amino acids, polyunsaturated fatty acids, vitamins, minerals, as well as polyphenols and antioxidants. [1,2] Those substances are known for their positive impact on cardiovascular, metabolic, and inflammatory diseases, which seems to be a promising basis for evaluating the possible beneficial influence of chia seeds in those areas. This is particularly important nowadays due to the recent accumulation of those illnesses in the human population, which sparks major concerns regarding global health and brings motivation to seek solutions to that widely spread problem.

The aim of this review is to analyze, evaluate and summarize the actual knowledge on the impact of chia seeds on human health, focusing on their influence on cardiovascular diseases, excessive body weight, glucose metabolism disorders and inflammation.

2. Chemical Composition

The unique chemical composition of chia seeds is what stands for their high nutritional value. Chia seeds consist mainly of protein, lipids, carbohydrates and dietary fibre. The exact values of the particular macro-elements are: carbohydrates - 21.8%, fat - 18.3%, protein - 18.85% and fiber 35.1 %. [1] The seeds also contain phenolic compounds and bioactive substances, as well as vitamins and minerals. [1,2]

2.1 Protein

High protein content (almost 19% of chia seeds' mass) is what makes chia seeds stand out from other grains. Chia seeds contain over twice as much protein as rice and around 1/3 more protein than wheat. [2]

Moreover, protein in chia seeds consists of a wide variety of amino acids, which is fundamental for a healthy diet. Chia seeds contain both essential amino acids: arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, as well as non-essential ones: cystine, tyrosine, alanine, aspartic acid, glutamic acid, glycine, proline and serine. [8]

The high protein content of chia seeds and their wide variety of amino acids is especially beneficial in present times, since a typical diet abounding in processed food rarely provides recommend amount of protein, and the chia seeds supplementation could help with maintaining a well-balanced, nutritious diet.

2.2 Fats

One of the main nutritional benefits of chia seeds is their significant content of unsaturated fats. Over 90% of fats within the chia seeds are unsaturated. [1] Among the unsaturated fats, there are especially valuable polyunsaturated fatty acids: α -linolenic acid (omega-3 fatty acid) and linoleic acid (omega-6 fatty acid). Alpha-linolenic acid makes up 59.2% of the fat in chia seeds, while linoleic acid makes up around 19.5%. [1, 2]

Omega-3 fatty acids are known for their positive impact on human health, especially thanks to their cardioprotective and anti-inflammatory actions. A recent meta-analysis by Khan et al. (2021) proves that supplementation of omega-3 fatty acids results in a reduced cardiovascular mortality, as well as a reduction in the number of non-fatal myocardial infarctions and coronary heart disease events. [23]

Omega-6 fatty acids, on the other hand, are characterized by their positive impact on serum cholesterol profile. A recent meta-analysis by Zhang et al. (2025) proves that supplementation with omega-3 fatty acids helps to lower triglycerides and total cholesterol levels. [24]

Such specific fatty acid composition within chia seeds, therefore, suggests their cardioprotective, anti-inflammatory, and cholesterol-reducing properties.

2.3 Fiber

Another prominent characteristic of chia seed composition is its high content of dietary fiber.

Chia seeds consist of fiber in 35.1%. [1] A significant amount of fiber in the diet slows down the digestion and hence decelerates glucose absorption. Moreover, its ability to increase volume by forming a gel-like substance decreases the subsequent hunger, which may help reduce food intake.

2.4 Vitamins and minerals

Chia seeds are especially rich in minerals such as Magnesium, Phosphorus, Calcium, Potassium, Sodium, as well as vitamins such as Vitamin A, Vitamin E, Vitamin C, Thiamine, Riboflavin, and Niacin. [2] The chia seeds could therefore be a good source of those elements and an accessible way to supplement the deficiencies.

2.5 Phenolic compounds and bioactive substances

Chia seeds contain a wide range of phenolic compounds and other bioactive substances that contribute to their antioxidant and anti-inflammatory properties. Dry chia seeds contain almost 9% of phenolic compounds. [2]

The main bioactive compounds found within chia seeds are: caffeic acid, chlorogenic acid, querencetin, rosmarinic acid, gallic, cinnamic, myricetin, kaemferol, as well as isoflavones, such as daidzein, glycitein, and genistein. [2] A list of all phenolic compounds found within chia seeds includes: alvianolic acid F, two dihydroxybenzaldehyde isomers, methyl rosmarinic acid, rosmarinic acid glucoside, salvianolic acid B/E, dihydroxybenzoic acid, fertaric acid, caffeoyl glucoside, caffeoyl gentiobiose, sibiricose A3, dihydroxybenzoic acid apiosyl glucoside, caftaric acid, oresbiusin A, vanillic acid glucoside, salvianic acid, dihydroxybenzoyl glucoside, and dihydroxyphenylacetic acid.[1]

The most important feature of the bioactive compounds is their antioxidant activity. The mechanisms in which they act antioxidantly include: prevention of chain initiation, binding of transition metal ion catalysts, decomposition of peroxides, prevention of continued hydrogen abstraction and radical scavenging. [9] Those features are particularly relevant to human health, since oxidative stress is one of the major factors in the pathogenesis of chronic illnesses.

3. Effects on Cardiovascular Health

Cardiovascular diseases are the leading cause of mortality in our society. They are associated with risk factors such as hypertension and dyslipidemia, which are potentially modifiable - possibly by dietary changes. Recently, a few studies have been conducted, which aimed at assessing the potential influence of chia seeds on the modifiable cardiovascular disease risk factors.

3.1 Blood pressure

Evidence from controlled trials and meta-analyses is consistent and indicates a positive impact of chia seeds on both systolic and diastolic blood pressure.

In a randomized controlled trial by Alwosais et al. (2021), 42 participants with type 2 diabetes supplemented 40 g of chia seeds for 12 weeks, which resulted in a significant reduction of their systolic blood pressure compared to the control group. [3] Similar patterns were observed in two recent meta-analyses. In a meta-analysis by TaghipourSheshdeh et al. (2025), chia seed consumption was proven to reduce systolic blood pressure by 7.19 mmHg and diastolic blood pressure by 6.04 mmHg. [4] In a meta-analysis by Saadh et al. (2025), chia consumption resulted in the systolic blood pressure reduction by 5.61 mmHg and diastolic blood pressure reduction by 7.49 mmHg. [5]

3.2 Lipid profile

Lipid profile plays a major role in cardiovascular health. Specific parameter changes in serum lipid profile, such as increased levels of low-density lipoprotein cholesterol (LDL-C) and triglycerides, and decreased levels of high-density lipoprotein cholesterol (HDL-C), can lead to atherosclerosis, and, in further steps, to serious cardiovascular events such as stroke and myocardial infarction.

The effects of chia seed supplementation on lipid profile are less consistent than those regarding blood pressure. In a systematic review by Ferreira et al. (2015), which assessed the impact of chia seed supplementation on lipid profile, no significant changes in lipid profile were observed. The authors, however, noticed an increase in alpha-lipolic acid and eicosapentaenoic acid levels associated with chia seed consumption. Those findings suggest that chia seeds might improve the composition of fats by increasing the concentration of omega-3 fatty acids, rather than improving the general lipid profile. [6] Similar conclusions were drawn in a recent meta-analysis by Fateh et al. (2024), which also proved no significant effects of chia seed supplementation on lipid profile after analyzing multiple randomized controlled trials. [7]

4. Effects on Metabolic Diseases

Metabolic diseases are an increasing problem in our society. There is a growing number of patients who suffer from metabolic disorders such as impaired blood glucose metabolism and excessive body weight, which overlap and to a great extent emerge from unhealthy lifestyle habits. Due to the wide prevalence of those disorders, their negative consequences, and a clear lifestyle background, an easy way of coping with them, such as chia seed supplementation, would be a precious invention. That is why the potential beneficial properties of chia seeds in those disorders were the subject of various studies.

4.1 Glucose metabolism

A randomized controlled trial by Vuksan et al. (2010), which assessed the effect of consumption of chia seeds on postprandial glucose, revealed a significant reduction in postprandial glycemia that was dependent on the dose of chia supplementation. [17] Such results may be explained by the chia seeds' high fiber content and their ability to severely increase volume, which could lead to slower digestion, slower glucose absorption, and consequently, lower blood glucose spikes after meals.

The influence of chia seeds on other glucose metabolism-related parameters is less clear. A recent meta-analysis by Pam et al. (2024), which aimed at assessing the effect of chia on fasting blood glucose, glycated hemoglobin and insulin, showed no significant changes in the levels of those parameters after chia seed

supplementation. [15] No positive effect of chia seeds on glycemic control (fasting blood glucose and glycated hemoglobin) was also observed in a meta-analysis by Faranak TaghipourSheshdeh et al. (2025). [16]

Those results suggest that the impact of chia seeds on glucose metabolism comes down mainly to lowering postprandial glycemia rather than bringing positive long-term effects on glucose metabolism in the form of improving parameters such as fasting glucose levels, glycated hemoglobin, or insulin.

4.2 Weight and BMI

Chia seeds' high fiber content could have a positive effect on excessive body mass due to their ability to swell and induce satiety. Such an assumption is consistent with the findings of a randomized controlled trial by Vuksan et al. (2017), which demonstrates that chia seed supplementation in patients with type 2 diabetes results in a significant reduction in waist circumference and total body mass when compared to the control group. [18]

Findings of this study are, however, not consistent with more recent meta-analyses. A meta-analysis by Faranak TaghipourSheshdeh et al. (2025) shows no significant changes in body weight, body fat percentage, waist circumference, or BMI after chia supplementation. [16] Whereas a meta-analysis by Karimi et al. (2024) demonstrates that chia consumption has no significant effect on body mass index, but triggers a significant reduction in waist circumference. [19]

It is clear that the results of presently available studies show inconsistencies. While some of them demonstrate a positive impact on waist circumference and total body mass, others do not support those findings. Further studies are necessary to fully assess chia seeds' potential in that area.

5. Effects on Inflammatory Diseases

High content of products with antioxidant capacity such as polyphenols, omega-3 fatty acids and bioactive compounds found in chia seeds, stands for their anti-inflammatory and antioxidant properties. Those properties were the subject of a recent meta-analysis by Pam et al. (2024), which aimed at assessing the influence of chia seeds on inflammation parameters such as CRP, IL-6, and TNF- α in patients with type 2 diabetes or with excess body mass. The study showed a significant reduction in CRP levels within individuals with a 12-week or longer intervention and dosage of chia seeds over 35 grams per day. There was, however, no significant change in IL-6 or TNF- α levels. [20]

Another similar study by Guevara-Cruzaimed et al. (2012), which aimed at assessing the effects of particular dietary supplements (including chia seeds) on health parameters in individuals with metabolic syndrome, found that there was a significant reduction in CRP levels in the group consuming a dietary pattern including chia seeds for two months. [21] Those findings further reinforce the potential anti-inflammatory action of chia seeds, however, the evidence is limited because of simultaneous supplementation of other products (Nopal, Soy Protein, and Oat), which does not allow for drawing straightforward conclusions.

Overall, the experiments demonstrate chia seeds' ability to reduce inflammation, which is depicted by a significant reduction of CRP levels. The results are, however, not fully consistent - certain inflammation parameters remain constant and seem not to be dependent on chia seed supplementation. The anti-inflammatory response is apparent but rather limited and noticeable only in selective biomarkers. Presently available studies are rare and heterogeneous, which emphasises the need for further research to fully assess chia seeds' capabilities.

6. Safety And Potential Risks

Chia seeds' rising popularity and growing worldwide consumption raise concerns about their safety. In response to those concerns, the European Food Safety Authority issued its scientific opinion on the safety of chia seeds and concluded that the use of chia seeds in moderate amounts is unlikely to have an adverse effect on public health. [10] There are, however, several potential negative effects that chia seeds may bring, which should be considered.

6.1 Risk of choking and esophageal obstruction

Chia seeds have significant hydrophilic properties - they absorb water rapidly and significantly increase their volume, creating a swollen gel-like mass. This creates a potential choking hazard, which was documented by Simmelink et al. (2017). The case report presents an incident of esophageal obstruction by chia seeds, which were consumed dry and expanded after further contact with fluids. [11] This suggests that chia seeds should be mixed with a sufficient amount of liquids before consumption, especially in patients with swallowing issues.

6.2 Allergic reactions

Food allergies are getting more common, which raises concerns about the potential allergic reactions to chia seeds. European Food Safety Authority (2009) stated that no allergenicity of chia seeds has yet been reported in the literature. [10] However, they emphasise that allergic cross-activity has been observed. This was also described in a recent case study by Kumar et al. (2024), in which a patient who consumed chia seeds, presented symptoms of anaphylaxis: generalised urticaria, abdominal pain, vomiting, diarrhea, tongue swelling and the feeling of throat closing, which required treatment with epinephrine. The patient had a documented sesame allergy, which implies the possible cross-reactivity between chia and sesame that could be explained by their protein homology. [12] This suggests that chia seeds may not be appropriate for patients allergic to products with a similar protein structure to chia seeds, such as sesame and mustard. [10]

Although there are no cases of direct chia seed allergy and rather cross-reactions have been observed, chia seeds should be used carefully, especially in individuals with a known history of food allergies. Additionally, new cases of allergic reactions may occur due to the increasing consumption of chia.

6.3. Toxic elements

One of the most common concerns about dietary products is their content, particularly the concentration of toxins and heavy metals. The increasing consumption of chia seeds sparks concerns about the possible exceeding of healthy limits of specific substances. This has motivated researchers to assess the levels of chemicals within chia seeds.

A study by González-Weller et al. (2024) revealed that chia seeds contain potentially toxic elements such as aluminium, nickel or strontium. Their levels, however, are low and allow for safe consumption with no health risks - provided that the seeds are consumed in moderate quantities. Nonetheless, the authors emphasise the significant quantities of copper and manganese found in the seeds, which, in case of excessive chia seed consumption, could result in exceeding the reference limits of those metals. [13] This presents the importance of moderation in the consumption of chia seeds and the need to assess the quality of products that hit the market.

Another aspect related to the potential toxicity of chia seeds is their thermal processing. A study by Mesías et al. (2023), which aimed at assessing the formation of harmful substances during thermal processing of chia seeds, found the appearance of acrylamide and furanic compounds during the process of chia seed baking. [14] Those elements can be harmful for human health, especially when consumed in large amounts, which raises questions about the safety of baked products containing chia seeds.

7. Discussion

The performed research implies that chia seeds have a unique chemical composition, rich in polyphenols, omega-3 fatty acids, and bioactive compounds [1,2] that may contribute to the management of cardiovascular, metabolic, and inflammatory diseases. Even though the chemical content of chia seeds and the mechanisms of action of their components present a solid base for their health-promoting properties, the results of clinical studies remain heterogeneous and in some areas inconclusive.

One of the strongest pieces of evidence of chia seeds' health-promoting action is their impact on blood pressure. Evidence from controlled trials and meta-analyses is consistent and indicates a positive impact of chia seeds on both systolic and diastolic blood pressure, seen as a significant decrease in both parameters after chia seed supplementation. [3,4, 5] Other investigated effects are less consistent. According to studies, chia seed supplementation did not result in any significant changes in lipid profile.[6,7] An increase in omega-3 fatty acids levels was, however, observed, which suggests that chia seeds might improve the composition of fats, rather than improving the general lipid profile.[6] Similarly, the evidence regarding the impact of chia seeds on body mass seems to be inconsistent. While some studies demonstrate a positive impact on waist circumference and total body mass[18], others do not support those findings[16], despite solid theoretical mechanisms supporting increased satiety and reduced caloric intake. Moreover, the studies regarding glucose metabolism indicate that chia seed consumption affects postprandial glycemic reduction[17], most likely due to its high fiber content. The influence of chia seeds on other glucose metabolism-related parameters is less clear - no significant changes in blood glucose, glycated hemoglobin or insulin have been observed.[15,16] Finally, the anti-inflammatory properties of chia seeds are to some extent supported by experimental studies. They demonstrate chia seeds' ability to reduce inflammation, mainly by reducing CRP levels. [20,21] The results are, however, not fully consistent - certain inflammation parameters remain constant and seem not to be dependent on chia seed supplementation.[20]

The key findings of the research regard chia seeds' consumption safety. The general conclusion suggested by the European Food Safety Authority is that chia seeds are generally safe and are unlikely to have an adverse effect on health.[10] Some risks should, however, be considered, such as: risk of choking and esophageal obstruction,[11] cross-allergic reactions [10,12], and content of potentially toxic elements, especially if consumed in excess or thermally processed.[13,14] While the potential hazards are unlikely to happen, their possible appearance emphasizes the importance of careful and moderate consumption as well as the need for frequent quality controls of dietary products.

There are some limitations of the existing research on chia seeds. Some of the interpreted studies had small sample sizes and short intervention periods. They also present heterogeneity in their designs, including various population choices, different dosages of chia seeds, and durations of the experiment. Those issues emphasize the need for larger clinical trials that would last longer and be unified in terms of dosages, duration, and population choice, which would help draw more trustworthy and solid conclusions.

8. Conclusions

Analysed studies confirm chia seeds' abundance in protein, fiber, omega-3 fatty acids, polyphenols, and bioactive compounds and imply that their supplementation provides some health-promoting effects, mainly expressed as blood pressure reduction, an increase in the omega-3 fatty acids levels and antioxidant and anti-inflammatory actions.

The most distinct clinical effect of chia seed supplementation is visible in its ability to reduce blood pressure and increase the omega-3 fatty acids levels, which suggests its cardiovascular-protective possibilities. There is also clinical evidence of their favorable impact on postprandial glycemic levels and anti-inflammatory and antioxidant effects, however, those findings are not consistently supported by all studies. The evidence of their influence on body weight and long-term glycemic control is weak and rather inconclusive.

Chia seeds regular supplementation may help provide crucial nutrients, which have a proven positive impact on human health. The evidence of their beneficial properties is, however, not fully consistent and future research in this area is necessary. The seeds should therefore be treated as a healthy addition to a well-balanced diet rather than a medication for chronic diseases.

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