# A Comprehensive Review on Chia Seeds: Nutrient and Phytonutrient Profile and its Ameliorative Effects

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**ABSTRACT**

Chia seeds (Salvia hispanica), a nutraceutical food is a harbour of both macro nutrient (protein 18 -24%, fibre 30-34 %) and micro nutrients, especially antioxidants like polyphenols and other phenolic compounds, dietary fibre, omega 3 fatty acids and are found to be having therapeutic benefits especially in controlling and management of cardiovascular diseases, diabetes mellitus, hypertension and hepatic steatosis. The anti-inflammatory, anti-microbial and anti-ageing function of chia seeds accelerates the immunity, digestion and improves overall health keeping the recent life style disorders at bay. Chia seed has earned the moniker "super food" due to its positive health implications, which have attracted the attention of numerous food sectors. A comprehensive overview of nutritional content, phytonutrient profile, and the ameliorative effects of chia seeds on disease prevention and management such as cardioprotective, diabetes-controlling, immune-boosting, and antioxidant action is included in the current review paper.

**Keywords –** chia seeds; nutraceutical; phytonutrient; antioxidant; anti-inflammatory foods

## I. INTRODUCTION

Chia seeds, which are derived from the plant Salvia hispanica, have drawn a lot of interest recently thanks to their exceptional nutritional profile and potential health advantages. Due to their abundance of vital nutrients, bioactive chemicals, and useful characteristics, these tiny seeds have become a famous superfood. Historically prized by ancient civilizations like the Aztecs and Mayans. In this article, the nutritional chemistry, phytonutrient profile, and medicinal properties of chia seeds are briefly described using information from studies and research done on this traditional food that is still essential today.

Chia seeds are well known for having an exceptional nutritional profile, which makes them a vital supplement to a diet that is balanced. They are an excellent source of omega-3 fatty acids, particularly ALA, which is essential for preserving cardiovascular health and reducing inflammation. Additionally, noteworthy is the protein content of chia seeds, which includes a variety of critical amino acids required for a number of physiological processes. Chia seeds also include a lot of dietary fibre, which helps with weight management, satiety, and digestive health.

The bioactive substances in chia seeds have the potential to be beneficial to health. These include phytochemicals with antioxidant and anti-inflammatory properties, such as chlorogenic acid, caffeic acid, myricetin, kaempferol and quercetin[1].These bioactive components have been found in chia seeds, and they have been related to a number of health-promoting actions, including lowering oxidative stress, boosting immunological function, and preventing chronic illnesses.

In addition to its nutritional value and phytochemical profile, chia seeds also have medicinal benefits. Scientific studies have demonstrated their beneficial effects on cardiovascular health, including the control of heart rate variations, improvement of heart rate variability, and decrease in irregular heartbeats [1]. The treatment of ailments like heart failure, hypertension, and dyslipidaemia may benefit from the use of chia seeds.

Chia seeds are a versatile element in food preparations since they have useful characteristics. Chia seeds have a gel-like consistency when combined with liquid, which can be used as a thickener or egg substitute in recipes. Chia seeds are a beneficial ingredient for individuals looking for healthier options in cooking and baking because of their special quality, which improves the texture and nutritional content of a variety of foods. Chia seeds have drawn the interest of health-conscious people, researchers, and food lovers alike. They are a great addition to a diet that is well-rounded due to their nutritional diversity, phytochemical profile, and medicinal potentials. As chia seed research in science advances, it is becoming clearer and clearer how these seeds may

promote cardiovascular health, reduce inflammation, and support general wellbeing. A natural and nutrient-dense superfood that has been adored for centuries can be enjoyed by incorporating chia seeds into regular meals.

## II. UNVEILING THE PAST: THE HISTORICAL JOURNEY OF CHIA SEEDS

Chia seeds, which come from the Salvia hispanica L. plant, have long been a popular staple food. Native to the lowlands of Central America, these seeds are most common in southern Mexico and northern Guatemala [2]. Chia seeds, which are members of the Lamiaceae family and the Salvia genus, were frequently utilized by the ancient Mayas and Aztecs for food, traditional medicine, and even painting. Chia seeds have become more well-liked over time in a number of nations, including the United States, Argentina, Canada, Chile and Mexico[1].

Since it has been utilized as a food source since 3500 BC2, chia has long been recognized as a productive crop in central Mexico[3]. It is presently used in numerous food products across the globe[4]. The plant may thrive in a variety of saline, silty, well-drained soil types, as well as acidic and alkaline settings. Chia is a nutritious crop that can produce roughly 2,500 kg per acre when grown under ideal conditions, making it popular in East Africa due to its inexpensive cost.

Often described as "the seed of the 21st century," "new gold," "superfood," or "super nutrient" [5], these seeds are oval in structure, smooth and shiny, and varies in size from 1 to 2 mm. Black chia seeds are more prevalent than white chia seeds, and they come in a variety of seed coat colours, including grey, black-spotted, and white-spotted. Chia seeds have a rich history that dates back centuries, with their origins rooted in the ancient civilizations of the Aztecs and Mayans. These cultures recognized the immense nutritional value and therapeutic properties of chia seeds, incorporating them into their daily diet and utilizing them for various medicinal purposes.

Historical records indicate that chia seeds were a staple food for these indigenous civilizations, providing them with sustainable energy and endurance. The Aztecs referred to chia seeds as "running food" and believed that a single spoonful of chia seeds could sustain a warrior for an entire day. Their significance was further highlighted by the fact that chia seeds were used as offerings in religious ceremonies and were considered sacred.

The importance of chia seeds extended beyond their nutritional benefits. They were valued for their medicinal properties and were used to alleviate ailments such as joint pain, gastrointestinal issues, and skin conditions. The gel-like substance formed when chia seeds were mixed with water was employed as a soothing agent for irritated skin and as a poultice to promote wound healing. Over time, with the arrival of Spanish conquistadors and the subsequent decline of the Aztec and Mayan civilizations, the knowledge and use of chia seeds diminished[1]. However, chia seeds remained cultivated in certain regions of Central and South America, where their traditional uses were preserved among indigenous communities. In recent years, there has been a resurgence of interest in chia seeds due to their remarkable nutritional composition and potential health benefits. Research on the phytochemical composition of chia seeds has identified the presence of bioactive elements such kaempferol, chlorogenic acid, myricetin, quercetin and caffeic acid. These phytochemicals contribute to the antioxidant and anti-inflammatory properties associated with chia seeds. Meanwhile, chia seeds' nutrient profile has attracted interest. They are a great source of alpha-linolenic acid (ALA) and eicosapentaenoic acid (EPA), two omega-3 fatty acids. Chia seeds also boast high levels of dietary fibre, proteins (containing essential amino acids), vitamins, and minerals[1].These nutritional attributes have led to the recognition of chia seeds as a functional food with potential health-promoting effects.

As a result, chia seeds have gained popularity as a superfood and have found their way into various culinary creations, including smoothies, baked goods, and breakfast bowls. Their versatility and nutritional profile have made them a favourite among health-conscious individuals seeking to enhance their diet with natural and nutrient-dense ingredients. The history of chia seeds is deeply intertwined with the ancient civilizations of the Aztecs and Mayans, who recognized their nutritional and therapeutic value. After centuries of being underappreciated, chia seeds have experienced a resurgence in recent times due to their phytochemical profile, nutritional composition, and potential health benefits. As scientific research continues to unveil their remarkable properties, chia seeds have solidified their position as a valuable addition to a healthy and balanced diet.

The nutritional value of chia seeds has attracted increased interest in recent years. Due to their numerous health advantages, these small seeds are now a favourite among athletes. It includes a variety of antioxidant substances, including kaempferol, chlorogenic acid, myricetin and quercetin, as well as dietary fibre, high-quality protein, vitamins, and minerals[6]. Studies comparing the oil percentages of raw and roasted seeds from chia revealed that they were, respectively, 35.83% and 37.7%.These seeds also contain substantial amounts of phenols, with raw and roasted chia seeds having total phenol concentrations of 3.07 and 3.43 mg GAE/g, respectively [7]. Chia seed oil is a good source of linoleic acid and linolenic acid, which varied with cooking methods. Additionally, chia seed oil contains tocopherols, caffeic acid, and rosmarinic acid, with varying concentrations depending on the cooking process [8].Current research indicates that chia seeds have beneficial effects on blood lipid profiles, hypoglycaemic properties, hypotensive effects, antibacterial properties, and immunological responses. Given its immense nutritional and therapeutic potential , consumption of chia seeds has been unceasing in through diverse nations for a millenium[9]. The nutrient and chemical composition of chia seeds make them a promising crop for

commercialization, and advances in technology present excellent opportunities to establish a robust agricultural sector around this remarkable food source. This review aims to comprehensively characterize the nutritive and pivotal significance of chia seeds, also investigate their possible medical uses.

## III. NOURISHING ATTRIBUTES OF CHIA SEEDS: A FOCUS ON NUTRITIONAL QUALITY

The nutritional and nutraceutical benefits of chia seeds are widely acknowledged [10]. Factors such as climate, origin, and extraction techniques influence the quantity and composition of therapeutic components in chia seeds [11].Chia seeds are a rich source of dietary fibre, with approximately 30-34 grams per serving. The fibre content is mainly composed of insoluble fibre (85-93%) and soluble fibre (7-15%) [12]. These seeds polyunsaturated fatty acids (PUFA) content is around 25-40% and 55-60% omega-3 fatty acids. PUFA, particularly linolenic acid, which makes up around 60% of the total fatty acids, are the main way that chia seeds contribute to the fatty acid profile. They also contain EPA, linoleic acid, palmitic acid, oleic acid, and palmitic acid[8,7]. Compared to other plant sources, chia seeds have the highest concentration of α-linolenic acid (18–20%), making them an important source of long-chain unsaturated fatty acids. They contain more omega-3 fatty acids than flaxseeds do. Chia seeds also exhibit a healthy ratio of omega-3 to omega-6 fatty acids (0.35:0.3)[13]. Therefore, chia seeds are considered a potent source of omega fatty acids. Protein is another significant component of chia seed, comprising 18-24% of their composition[1]. The amino acid profile of chia seeds demonstrates the presence of 10 essential amino acids, with higher concentrations of leucine, lysine, valine, phenylalanine, and arginine. They also include a variety of naturally occurring amino acids, including aspartic acid, glutamic acid, serine, glycine, and alanine[14].Notably, chia seeds are devoid of gluten and therefore suitable for consumption by people who have celiac disease[2].Chia seeds are rich in minerals, with notable concentrations of potassium (K+), magnesium (Mg+), phosphorus (P), and calcium (Ca+). The research also identifies the presence of certain vitamins, including niacin, vitamin B1, and vitamin B2 [15]. Moreover, chia seeds contain a diverse range of phytochemical components that exhibit distinct biological activities[16]. Noteworthy polyphenols found in chia seeds include gallic acid, epicatechin, caffeic acid, cinnamic acid, chlorogenic acid, ferulic acid, quercetin, apigenin, rutin, p-coumaric acid and kaempferol[1].Chia seeds also contain stigmasterol, campesterol, 5-avenasterol, and sitosterol. Another benefit is that these seeds have also been found to contain tocopherols, such as alpha-, beta-, and gamma-tocopherol[17].

**Table 1:** Different functional components of chia seeds and their potential health benefits.

| Functional component | Present in part | Helpful in diseases | References |
|---|---|---|---|
| Fibre | Bran | Diabetes, CVD, and Constipation | Fernandes et al. (2021), Liu et al. (2002), Oliveira-Alves et al. (2017) |
| Antioxidants | Whole seed | Cancer and Diabetes | Alwosais et al. (2021), da Silva Marineli et al. (2014), Hajhashemi et al. (2010) |
| Polyphenols | Whole seed | Cancer and Alzheimer's disease | Oliveira-Alves et al. (2017), Shabbir et al. (2021) |
| Vitamins (E) | Whole seed | Cancer | EFSA (2009), Yang et al. (2012) |
| Minerals | Bran | Reduce BP | Ghafoor et al. (2018), Taneja and Mandal (2007) |
| Omega-3 Fatty acid | Mostly in endosperm | Reduce bad cholesterol and TG | Basuny et al. (2021), Pizzini et al. (2017), Porras-Loaiza et al. (2014) |

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The biological and chemical processes involved in seed isolation are significantly influenced by caffeine. The molecular building blocks for a number of metabolites present in the Lamiaceae family are phenolic acids, which are composed of a dihydroxyphenyl group linking an acrylic acid. The most prevalent metabolites in the polar isolation of Chia seeds are caffeoylquinic acids, particularly chlorogenic acid. These acids are created when

quinic acid binds to caffeine, also known as hydroxycinnamic acid, at various places. Chia seeds also contain polymers and monomers, including caffeic acid, which contribute to their metabolism[18].

Monomeric compounds from Chia seeds have been identified using ultra-high-performance liquid chromatography in Colima, Mexico [19]. The compounds include ferulic acid and caffeic acid. The amount of caffeic acid in Chia seeds was found to be lower than that in peach but higher than that in blueberry, papaya, and mango [20]. The polyphenolic existence in theses seeds, along with the phenolic compounds, contributes to their protection against oxidative deterioration[1]. The antioxidant compounds glycoside Q , caffeic acid, phenolic glycoside k ,quercetin and chlorogenic acid have each been identified in substantial amounts in chia seeds[21].

Flavonoids, a subclass of polyphenolic compounds, are widely distributed in plants and play essential roles in colour, flavour, and preventing fat oxidation in food[22]. Due to their antimicrobial, anti-inflammatory, hepatoprotective, antioxidant, anti-cancer, and antiviral capabilities, they have been linked to a number of health advantages[23]. Certain flavonoids, including myricetin, kaempferol, and quercetin, have been discovered in methanol hydrolysed extracts of chia seeds[11]. Other studies identified myricetin and daidzein as prominent flavonoids in chia seeds[19].

## IV. UNLOCKING THE HEALING POTENTIAL: EXPLORING THE THERAPEUTIC ADVANTAGES OF CHIA SEEDS

Chia seeds have been associated with various therapeutic benefits. High levels of antioxidants such myricetin, kaempferol, chlorogenic acid, caffeic acid and quercetin are present in them; these compounds have anti-cardiovascular, anti-hepatic, anti-carcinogenic and anti-aging properties[1]. Chia seeds' high dietary fibre content helps with digestion and hyperglycaemic control. Additionally, chia seeds contain gluten-free protein, vitamins, and polyunsaturated fatty acids (PUFA) with therapeutic effects in controlling hypertension, diabetes, and dyslipidaemia. Acting as antioxidants, they also have anti-blood-clotting, anti-inflammatory, anti-anxiety, anti-depressant, laxative, analgesic, immune system-boosting, and vision-improving properties[24].

Eicosapentaenoic acid (EPA) and linolenic acid play an influential role in the genesis of crucial biological molecules like leukotriene, prostaglandin, and thromboxane required for multiple physiological activities inside the body.Omega-3 fatty acid consumption, including alpha-linolenic acid is related with improvised cardiovascular functions reducing heart rate fluctuations, parasympathetic tone, and abnormal heartbeats [25]. Increased intake of alpha-linolenic acid has also been shown to significantly reduce the risk of heart failure [26].

The numerous health advantages of chia seeds have attracted attention. Chia seeds contain more iron, fibre, magnesium, and calcium than milk, according to research done at St. Michael Hospital in Toronto, Canada. Being gluten-free these seeds with a daily intake of 37 grams, can help diabetes patients' blood glucose levels stay stable. Omega-3 fatty acids, found in abundance in chia seeds, can lower systolic blood pressure by up to 6 mmHg preventing platelet aggregation and reducing the risks of myocardial infarction and strokes[26].

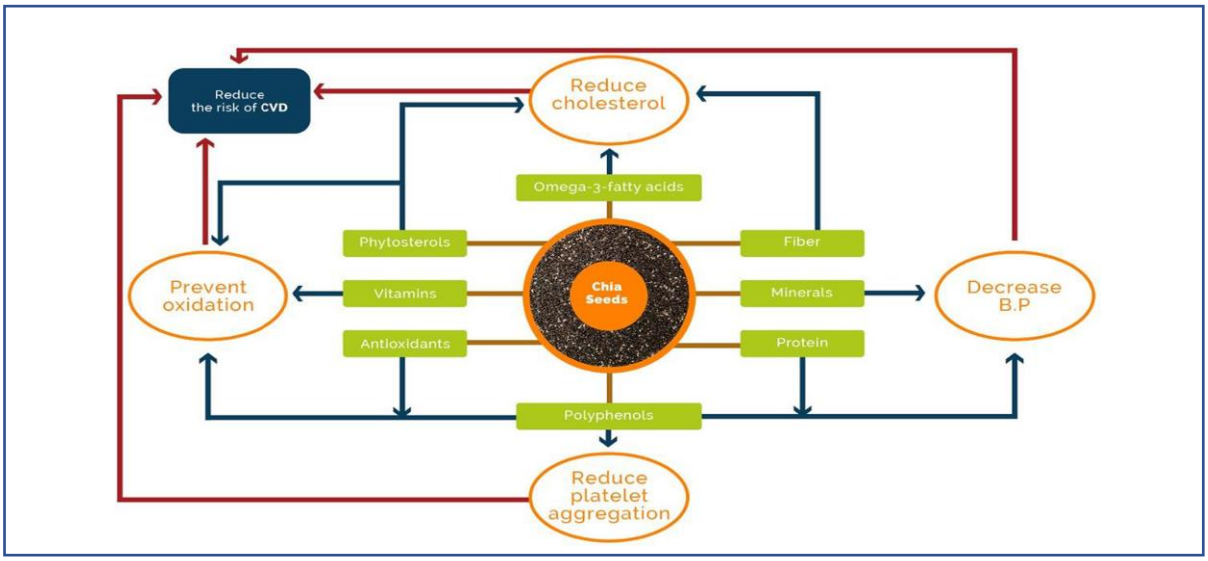


**Figure 1: Role of chia seeds in cardiac health and preventing dyslipidaemia;** Food Science & Nutrition, Volume: 11, Issue: 1, Pages: 3-16, First published: 15 December 2022, DOI: (10.1002/fsn3.3035)

Chia seeds possess several medicinal properties, including anti-blood clotting effects, prevention of stress induced neurological disorders like seizure disorder, management of hypercholesteremia and immunological

disorders. Consumption of chia seeds during pregnancy has been found to enhance the foetus's visual and cognitive growth [27]. Studies have shown that including chia seeds in male Wistar rats diet increases high-density lipoprotein cholesterol while significantly reducing triglyceride levels[28].

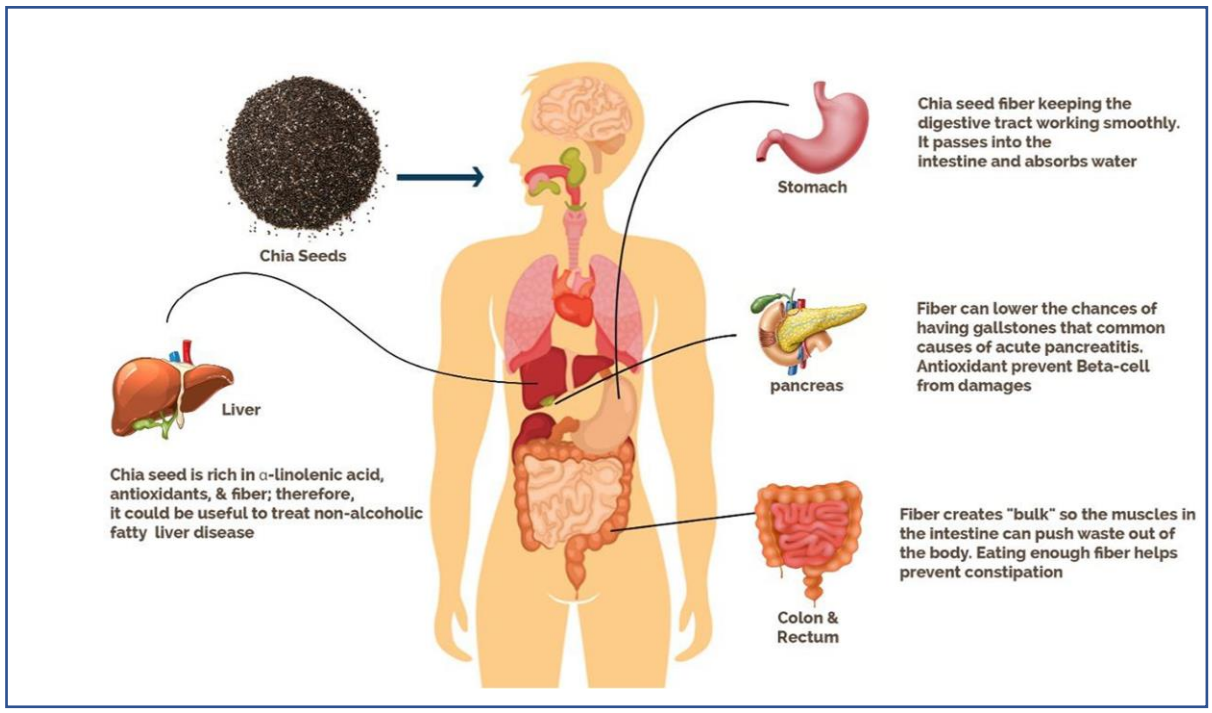


**Figure 2: Role of chia seeds in metabolic disorders**; Food Science & Nutrition, Volume: 11, Issue: 1, Pages: 3-16, First published: 15 December 2022, DOI: (10.1002/fsn3.3035)

The chia seed's antioxidant related benefits have been extensively documented. Chia seed extracts have been showed to increase the activity of antioxidant enzymes in obese rats, leading to enhanced antioxidant defence mechanisms[29,30]. Chia seeds have also demonstrated the ability to scavenge free radicals, such as ABTS cation radicals and DPPH radicals, and prevent lipid peroxidation[31] [32] .

Chia seed and its oil has been incorporated in the animal studies and major anti-obesity changes have been observed in the trailed group of animals. Chia seed administration has shown positive effects on insulin secretion, blood glucose control, reduction of visceral fat , fatty liver disease, fibrosis of the heart and the liver, inflammation, and the inhibition of the activity of stearoyl-CoA desaturase (SCD) [33]. Suppression of SCD activity protects against insulin resistance and other metabolic disorders associated with it. Chia seeds, rich in dietary fibre, contribute to improved gastrointestinal motility and prevent constipation. They also provide essential nutrients such as solid lipids, proteins, and cancer-preventive compounds[34] [35]. Soluble chia seed extracts have been found to promote the integrity of the intestinal barrier by enlarging the area, density and width of the intestinal villi cells which play a vital impact on higher cellular growth of the enterocyte as well as higher mucus yield. This advances the digestibility and absorbability intensity of the microvillus membrane of the enterocyte [35].Chia seed peptides have shown potential in skin rejuvenation processes and reducing the chances of skin disorders.[1] Peptides derived from chia seeds exhibited inhibitory effects on enzymes associated with skin aging, including collagenase, tyrosinase, hyaluronidase, and elastase. These findings suggest that chia seed peptides can protect against skin aging by preserving the skin protein matrix [37].

## V. CONCLUSION

A nutritional powerhouse with therapeutic potential and a wealth of phytochemicals that can benefit human health, chia seeds have demonstrated their superiority. Highlighting the dietary predominance throughout the ages of various cultures, utilization of chia seeds continues to be a contemporary scientific approached culinary practice. Due to the diverse phytochemical profile and therapeutic potential, incorporating chia seeds into the diet can enhance the nutritional quality and possibly aid in the prevention of a broad spectrum of diseases and disorders [11].

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