

## Review Article

# Chia (*Salvia Hispanica*): An Overview of Its Botany, Uses, Reproductive, Biology, Pharmacological Properties and Industrial Potentials

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## Abstract

The consumption of chia seed (*Salvia hispanica* L.) has increased in recent years due to its high content of omega-3 and omega-6 fatty acids and dietary fibre. This seed also has a high concentration of proteins and essential amino acids, becoming a promising source of bioactive compounds such as chlorogenic acid, caffeic acid, myricetin, quercetin and kaempferol with the major phenolic acid being rosmarinic acid. Owing to the rich nutritional profile, chia seeds provide numerous health benefits such as cardiac and hepatic protective effects, anti-aging and anti-carcinogenic properties. The high amounts of dietary fibres present in the seeds also confer benefits by preserving good glycemic control thus helping in controlling diabetes mellitus. In addition to the food industry for the development of various baked products, production of biodegradable edible films, use as emulsifiers and stabilizers among other uses. In this article we have focused on drafting a technical description of the chia.

**Keywords :** *Salvia hispanica*; Nutritional; Fatty acids; Fibre and health benefits

## Introduction

Chia (*Salvia hispanica* L.), is an annual herbaceous plant belonging to the Lamiaceae family. This botanical species, native to southern Mexico and Northern Guatemala, was an important crop in pre-Columbian Mesoamerica in conjunction with corn, beans and amaranth. Chia seeds were valued not only for food, but also for medicines and paints [2]. Its cultivation was banned by Spanish conquerors and replaced by exotic crops (Wheat and Barley) [8]. Nowadays, chia seeds are being re-introduced to Western diets to improve human health.

Chia seed is traditionally consumed in Mexico to South Western U.S. and South America, but it is not widely known in Europe. However, in 2009, the European Union approved chia seeds as a not widely food, allowing them to comprise up to 5% of a bread product's total matter [3]. Today, chia is mostly grown in Mexico, Bolivia, Argentina, Ecuador, Australia and Guatemala and it has been demonstrated that the species has great potential as a future crop plant [13].

The value of chia arises from its nutritional properties and medicinal use. The contents of chia seeds include polyunsaturated fatty acids, dietary fibre, vitamins, calcium, protein including all essential amino acids and other vital minerals [35-45].

After a long oblivion in recent years this crop has been rediscovered, nowadays it is cultivated as a seed crop and commercialized as a functional food and feed. Chia seeds are perhaps one of the most advantageous nourishment on earth, stuffed with supplements and medical advantages for the human body and mind. Health benefits include nourishing the digestive system, promoting healthier skin, strong muscles and bones, lower the risks of cardiovascular diseases, diabetes and ageing signs [1-45]. Mature chia seeds contain mucilage in their epidermal cells thus, when the seed is placed in water, the primary cell layer obtrudes from the epidermal cells developing a coating around the seed which surges in size and forms a gel-like appearance on chia [36]. This gel characteristic being a natural phenomenon of chia seed has great potential in the development of functional food products such as stabilizers, emulsifiers and thickeners [15]. Moreover, over the years special attention has been drawn to the use of chia as feed, for instance dairy industries have explored improving the nutraceutical profile of milk by increasing the content of Polyunsaturated Fatty Acids (PUFA) omega-3 fatty acid [18]. The lipid profile in milk can be sharply modified by feeding animals with forages rich in omega-3 [18] as well as by supplementing oils seeds or fish oils [12]. Chia,

therefore offers massive nutritional and therapeutic potential with a diverse future perspectives for food, feed, pharmaceutical and nutraceutical sectors. Owing to its superior nutritional, functional and health benefits.

### Botanical Description of The Plant

*Salvia hispanica* L. is an annual herbaceous plant. Its height can reach from 1 to 1.5 meters, with branched stems of quadrangular and hollow section, with opposite leaves with serrated edges 80 to 100 mm in length and 40 to 60 mm in width. The flowers are hermaphroditic, purple, blue or white, usually with indehiscent fruits in groups of four oval single-seeded achenes 1.5-2 mm length and 1-1.2 mm in diameter [25-35].

The seeds are soft and shiny, gray-brown with dark brown spots, which can sometimes be white, they are small and light so the weight of the 1000 seeds can vary from 0.94 to 1.29g. It is a self-pollinating plant and insects are responsible for cross-pollination, but reproduction is most commonly encountered and accomplished through seed [36]. It is a photoperiod-sensitive short-day plant, exhibiting a favorable short-day flowering response [9-42]. Chia requires favorable conditions to grow optimally, it requires a hot climate and heavy rainfall with a temperature that must be 15 to 30°C [31].

Mexico is known to be the source and major producer of chia, but it has also recently grown in Australia, Bolivia, Colombia, Peru and Argentina [25-31]. Most plant operations of chia seeds are carried out in mountainous regions from temperate to subtropical [25].

### Chemical Composition

The nutritional properties of *Salvia hispanica* are high, specifically from its seeds which contain fats, carbohydrates, fibers and proteins, in addition to various vitamins, minerals and antioxidants. They can provide an energy value of 459 to 495 kcal/100g of seeds [29-31]. These values may be influenced by the ecosystems of the culture medium of *Salvia hispanica*, due to genetic factors [31], the extraction method [29], the effect of climatic conditions, the nutrients in the soil [25].

#### Lipids

The seeds are rich in fatty acids of polyunsaturated form such as omega-3 alpha-linolenic acid (19.5%) and omega-6 alpha-linolenic acid (5.2%), which the human body cannot synthesize due to the absence of specific [25-31].

#### Proteins

Content in chia seed is about 16-26%, in which most of them being prolamins about 538g/kg of crude protein, followed by glutelin about 230g/kg of crude protein, globulins about 70g/kg of crude protein and albumins about 39g/kg of crude protein. In addition to 18 amino acids, among them, the 7 exogenous amino acids and some endogenous amino acids (glutamic with the greatest concentration). They can provide more protein than

**Table 1:** Basic composition of chia seeds [28] according to [39].

Element	Concentration
Proteins	15-25%
Fatty acids	30-33%
Carbohydrates	26-41%
Dietary fiber	18-30%
Ash	4-4%
Minerals	90-93%

other grains such as rice, corn or barley [29-31].

#### Fibre

Found in high concentration in *salvia hispanica* according to [25] are: lignin, cellulose, hemicellulose and especially mucilage. The plant can provide about twice the amount of fiber as bran, and at least 4 times more than almonds, soy and quinoa [31].

#### Vitamins and Minerals

Vitamins and minerals are essential for the body, chia is a rich source of both. It is a source of vitamins A (54µg), B1 (0.62mg), B2 (0.17mg), B3 (8.83 mg), B9 (49mg), C (1.6mg) and E (0.5mg) per 100g of seeds. There are also traces of vitamins K and D. And as well as high concentrations of calcium (455mg), phosphorus (585mg), magnesium (340mg), potassium (585mg), iron (8.54mg) and zinc (3.70mg) per 100g of seeds [25-31]. They contain more calcium (6 times), phosphorus (11 times), potassium (4 times) than milk and more iron than liver [25-31].

#### Antioxidants

The antioxidants detected in the extracts of the seeds of *salvia hispanica* are polyphenols (0.51-0.97mg), chlorogenic (0.0459-0.235mg) per 1g of the seeds. It is only recently that agronomic studies have started all over the world to research the different interests of the chia plant. These studies show that in addition to the classic consumption of seeds, several innovative uses of seeds as well as chia leaves have been proposed [7].

#### Nutritional Interests

Chia is an oil seed crop with a high production of fatty acids, particularly omega-3 and omega-6, and fiber and it is used primarily for culinary purposes such as phytoremediation. The seeds, in turn, can be eaten whole after oil extraction, or ground as an additive to other food ingredients [4]. Chia seeds have a high protein content [7] and are used for their nutritional and medicinal properties, especially to improve the endurance of athletes during their physical activities, as an appetite suppressant, as an agent for slimming, as a glycemic control and as an intestinal regulator [33]. Also, during imbibition, the hydrated seeds secrete mucilage, the production of this mucilage suggests many applications [7] as in the drinks called « agua fresca » or « chia fresca » in Mexico. It is also commonly used in the preparation of fresh water and as an enrichment of baked goods [30]. According to [5], an adult with an intake of 2700 calories would need 22.5 to 26.5g/day of seeds or 6.7 to 7.9g/day of oil to reach the recommended daily requirements of omega-3 fatty acids. Chia can be incorporated into the human diet for its protein content and composition. The oil extracted from chia can be used as seasoning [35], or can be added to obtain functional foods in association with the seeds [40-46]. Chia seeds do not contain gluten which makes them interesting for gluten-free diets which are increasingly adopted. Indeed, the addition of chia to gluten-free flours improves their nutritional qualities and does not negatively affect their organoleptic characteristics [43]. In the United States, Latin America and Australia, chia seeds are widely used in the food industry for the production of breads, bars, cookies and breakfast products. In addition to its culinary consumption, chia can be used as a thickening and stabilizing agent in food products such as preserves, yogurts, mayonnaises and sauces [17], or to replace eggs or oil in baked goods [7]. United States dietary guidelines recommend consuming chia as your primary food source, chia

sprouts are used in salads, chia seeds are used in beverages and grain-based foods, and can be eaten in raw form [1-45].

### Medicinal Interests

Chia seeds have cardio-protective effects, thanks to the high concentration of omega-3 fatty acids that control hypertension and improve heart function and heart rate [25-45]. They also have the ability to lower total cholesterol levels, thanks to proteins that can block cholesterol synthesis and help reduce blood clotting. On the other hand, they can decrease the concentration of triglycerides [25-45]. They reduce the risk of developing diabetes by reducing the concentration of glucose in the blood, and insulin resistance [25-31]. Thanks to the dietary fiber and low carbohydrate concentrations in chia, they can help reduce appetite and weight loss [25-31]. They also have an antioxidant capacity [46], they have the ability to protect the body from the harmful effects of oxygenated molecules, which can limit inflammation and the development of cancer, it is also effective against neurological and immunodeficiency diseases and various brain diseases [25]. Chia seeds have healing ability and wound healing benefits, increased collagen levels in the skin [45], and have a rôle in improving vision, and in cell differentiation and growth [20], thanks to the vitamin A they contain, they assist in the absorption of iron and the biosynthesis of connective tissue thanks to vitamin C, and they can protect the body from cellular damage due to free radicals, as well the appearance of cancerous cells thanks to vitamin E. They contain vitamin B which can ensure the optimal functioning of the nervous system and T cells, and can participate in the synthesis of fatty acids and genomic repair during cell divisions, also contribute to many metabolic reactions, thus protect the body from anemia, inflammations, mental confusion, schizophrenia, impaired immune response, Alzheimer's disease and depressions, congenital malformations of the fetus [34].

They have other therapeutic gains thanks to the minerals that go into their composition such as; calcium which lowers blood pressure, prevents osteoporosis and adenomas in young people, and relieves pregnant women of blood pressure problems and cholesterol [14]. The potassium that containing in the seeds of chia can prevent the risk of cardiovascular diseases, the progression of chronic renal failure and strokes [11]. Phosphate is essential for intracellular signal transduction and in energy release reactions, the extracellular structure of the skeleton and teeth. It has a buffering effect to maintain total body pH [10]. Iron which carries and transports oxygen to all the tissues of the body, by what it enters into the formation of red blood cells. Zinc which is essential for division, T cell differentiation and organ development, digestion, wound healing and central nervous system function, bone mineralization. It can also influence the function of hormones, such as growth hormone, insulin, testosterone. These two minerals (Fe and Zn) react as antioxidant and anti-inflammatories, and help in the development of the fetus [26]. Magnesium and vitamin D protect the body from skeletal deformities and cardiovascular disease [47]. Chia seed can provide necessary proteins, such as: albumin which is responsible for transporting molecules in the blood (such as cations, fatty acids, hormones and drugs) [21-27], and has the ability to protect young people from several cardiovascular diseases and strokes [36], thanks to its anti-inflammatory, anticoagulant and antioxidant properties as well [37-44]. And such as globulin (gamma globulin specifically) which has importance in immunity, when it can treat immunodeficiencies and protect the body from various infections [38]. In other words, these

seeds have the ability to increase the level of IgE in the blood, which indicates to the improvement of body immunity [23-45]. The use of chia seeds as an antimicrobial is still under study, but nothing proven so far [23]. While the extract of their aerial parts has an inhibitory effect on certain fungi and bacteria [22].

### Commercial Interests

Chia is commonly used in the preparation of soft water, in the preparation of paint (oil) and as an enrichment in baked goods [6-30], or as a seasoning in culinary preparations or as an additive in cosmetic products [32-35]. Chia seeds are also widely used for the extraction of bioactive compounds for the development of functional foods [3]. In the United States, Latin America and Australia, chia seeds are hitting the food industry market. Chia is marketed in several forms: i) Whole seeds, ii) Chia seed flour, iii) Chia gel of mucilage, iv) Chia seed oil, v) Chia capsules, vi) Fruit juice with chia seeds [1].

### Conclusion

Chia has very important nutritional and medicinal qualities. Some were reasonably studied but others should be studied more thoroughly. There is an importance to expand the studies of the medicinal studies of the potential of chia products as nutritional sources, especially in terms of antiobesity agents. Standardization of chia seeds and extracts leaves extracts can be carried out for direct use against various above mentioned problems and further research can be undertaken for isolation, purification and pharmacological validation of active constituents responsible for particular pharmacological activity.

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