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Salvia Hispanica L. (Chia): A Review of Plant Morphology, Cultivation, Nutritional Values, Health Benefits and Recipes

Dr Seema Gupta

Associate Professor, Department of Botany, Fateh Chand College for Women, Hisar, Haryana, India

ABSTRACT: Chia, or *Salvia hispanica*, is a native plant of Central America that has become well-known throughout the world for its many culinary uses and health advantages. This review article sheds light on the potential of chia seeds as a functional food by providing a thorough review that focuses on their morphological traits and nutritional makeup. *Salvia hispanica* seeds exhibit a range of colors, including white, brown, black, and speckled variations, and are oval and small in size. Chia seeds provide a wide range of vital elements, including fibre, protein, and omega-3 fatty acids, as well as vitamins and minerals. Their numerous health advantages, which include enhanced cardiac function, diabetes regulation, weight loss, and antioxidant qualities, are attributed to these constituents. Moreover, studies have demonstrated that chia seeds have special hydrophilic qualities, this characteristic improves their adaptability in the kitchen and facilitates satiety and digestion.

KEYWORDS: Chia seeds, nutrients, diabetes, weight loss, hydrophilic, functional food

I. INTRODUCTION

Nutraceuticals and health foods are experiencing rapid growth on the worldwide marketplace. The primary causes are a growing elderly population as well as consumer interest in and knowledge about nutritious foods as a kind of preventive health care. *Salvia hispanica* seeds have multiple health advantages, including a lower risk of heart disease, malignancy, and strokes. They are an excellent source of Omega fatty acids, unsaturated fatty acids, and soluble dietary fibers. Owing to their many health advantages, they are often referred to as golden or super seeds. For the Maya and Precolumbian Aztec societies of Mesoamerica, *Salvia hispanica* was a significant crop and dietary staple. These days, this crop is farmed commercially in a number of nations, including Peru, Argentina, Australia, and the United States. Mexican chia, or chia, is a common term for a few species of *Salvia*. Chia is indigenous to Guatemala and Mexico (Madaan et al., 2020). Because chia seeds have a high oil content, the name "chia" comes from the Nahuatl word "chian," which means "oily." This crop was just as significant as maize to the pre-Columbian inhabitants of Mesoamerica, who used it for food preparation, traditional remedies, and artistic and religious purposes. As a source of energy, the ancient people ate roasted and pulverised chia seeds together with other foods like amaranthus seeds. *Salvia columbariae* known as golden or desert chia, is native to the southwest of the United States and northern Mexico, as a food source. It yields seeds that resemble chia seeds in appearance, although their nutritional profiles could differ. Indigenous peoples used to gather and eat golden chia seeds, grinding them into flour or combining them with water to create a nourishing drink. Golden chia seeds are an important dietary source in dry areas because, like chia seeds, they are high in protein, fibre, and omega-3 fatty acids.



II. SYSTEMATIC POSITION

The systematic position of chia (*Salvia hispanica*) within the plant kingdom is as follows:

Kingdom: Plantae (Plants)
Subkingdom: Tracheobionta (Vascular plants)
Superdivision: Spermatophyta (Seed plants)
Division: Magnoliophyta (Flowering plants)
Class: Magnoliopsida (Dicotyledons)
Subclass: Asteridae
Order: Lamiales
Family: Lamiaceae (Mint family)
Genus: <i>Salvia</i> (Sage)
Species: <i>Salvia hispanica</i> (Chia)

III. MORPHOLOGY

Habit: It is an annual herbaceous plant with 3-5 feet height and exhibits upright branches arising from the base of the plant. Chia plants offer a lovely appearance, vibrant blossoms, and lush leaves. There are aromatic essential oils in every section of the plant. Because of their aesthetic appeal, they are frequently planted as ornamentals in gardens and landscapes. Chia plants put on a remarkable show of colour and complexity when they are fully bloomed, drawing pollinators and people to the plant.

Leaf: Leaves are arranged in opposite decussate manner. Usually oblong to lanceolate in shape, the margins of the leaves are toothed or serrated. Their texture is rough and their colour ranges from mild to dark green. The length of the leaves can vary, spanning from 2 to 4 inches.

Flowers: Flowers are tiny, tubular, bilipped, hermaphrodite, pedicellate, zygomorphic and arranged in verticillaster inflorescence. Depending on the variety, they may be lavender, blue, purple, or white in colour.

Seeds: Chia seeds are tiny, oval-shaped and, depending on the kind, can be white, grey, black, or brown in colour. Each seed has a smooth, glossy surface and is between one and two millimeters in size. Chia seeds are covered with mucilage and when soaked in water, it gives a gelatinous feel.

Root System: To absorb water and nutrients, chia plants' fibrous roots grow out horizontally and pierce the earth. The roots penetrate the soil to a depth of roughly 12 to 18 inches.

CULTIVATION

Chia plants are appropriate for cultivation in many parts of the world due to their vast ecological tolerance and ability to adapt to a wide range of environmental circumstances. For best development and productivity, they do need enough sunlight, well-drained soil, temperature in between 16-26°C (*Grimes et al., 2023*) and a suitable amount of moisture. The plants require light clay, sandy soils that drain well (*Nunawath et al., 2023*). The recommended planting rate per hectare is 6 kg, with rows spaced about 2.5 feet apart. The frequency of irrigation varies from none to eight times throughout a single growing season, depending on the climate. Fertilizers might be necessary or not. Chia may be cultivated naturally since the essential oils in the leaves repel insects. The range of seed output per acre is 400–200 pounds. The growing cycle lasts anywhere from 100 to 150 days, depending on height and region.

The following steps are involved in the cultivation of chia seeds:

- 1. Seed Selection:** To ensure optimal germination rates and robust seedlings, premium chia seeds are chosen for sowing.
- 2. Soil Preparation:** Chia plants require rich, well-drained soil that has a pH of 6.0 to 7.5 (*Motyka et al., 2022*). Soils with a sandy loam or loamy texture are favoured because they offer optimal drainage and oxygenation for plant roots. To avoid root rot and other soil-borne illnesses, chia plants require proper drainage because they are susceptible to waterlogging.
- 3. Planting:** Chia seeds are usually planted directly in the ground, between 1/4 and 1/2 inch (0.6 and 1.3 cm) deep. Depending on the variety and growing circumstances, the seeds are arranged in rows every 6 to 12 inches (15 to 30 cm) apart.
- 4. Watering:** During germination and the early phases of growth, chia seeds need regular watering. Chia plants can tolerate arid environments and are drought-tolerant once they are established.
- 5. Maintenance:** To achieve ideal development and yield, chia plants may occasionally need to be weeded and treated

for pests. If deficiency of nutrients in the soil, fertilization might be required. **6. Harvesting:** Depending on the species and growing circumstances, chia seeds can be harvested 100 to 120 days after sowing. When the seed heads dry out and turn brown, the plants are harvested. After cleaning and threshing, the seeds are prepared for processing or storage.

Common Weeds and Pests

Chia plants are resistant to pests, diseases, and insects, they may be produced organically, which has advantages for selling them in the health food industry. But few weeds and pests which may harm this plant are listed below:

Weeds and Control measures

1. Chia plants may face competition from Foxtail and Crabgrass for sunlight, nutrients, and water, which could lower crop yields. Regular weeding, mulching to inhibit weed growth, and applying pre-emergent herbicides prior to planting to stop weed seeds from sprouting are some preventative measures.
2. Purslane and Pigweed can swiftly proliferate and clog chia fields. To control such broadleaf weeds without damaging chia plants, methods such as mechanical cultivation, hand weeding, and the application of herbicides with specific targets can be employed.
3. Canada thistle a perennial weed in chia can be controlled by regular mowing, repeated cultivation, and focused pesticide application.

Pests and Control measures

1. **Aphids:** Chia plants are susceptible to infestations by these tiny, sap-sucking insects, which result in slowed growth, warped leaves, and lower yields. Aphid populations can be managed by predatory creatures like ladybirds and lacewings; if necessary, aphids can be discouraged with insecticidal soaps or neem oil sprays.
2. **Cutworms:** These caterpillars destroy young plants by feeding chia seedlings and chopping them off at the base. Cutworm damage can be avoided by taking preventative steps such putting chia seedlings deeper in the soil, enclosing plants with cardboard rings or collars, and using biological insecticides that contain *Bacillus thuringiensis* (Bt).
3. **Whiteflies:** These tiny, flying insects cause yellowing, wilting, and decreased vigour in chia plants by draining sap from their leaves. Adult whiteflies can be observed and trapped using yellow sticky traps; whitefly populations can also be managed with the use of insecticidal sprays or natural predators like parasitic wasps.
4. **Spider mites:** By puncturing leaf tissue and draining out cell contents, these microscopic arachnids feed on chia plants, causing stippling, discoloration, and webbing on leaves. Spider mite infestations can be controlled with routine observation, appropriate irrigation to preserve plant health, and the application of miticides or insecticidal soaps.

IV. NUTRITIONAL VALUES

Because of its chemical makeup and technological characteristics, chia seeds have excellent nutritional value and can be used as whole seeds, flour, mucilage, or oil. Because of their high levels of omega 3 and 6 fatty acids, proteins that contain a good amount of essential amino acids, water soluble and insoluble fibers, minerals, antioxidants, and phenolic compounds like caffeic, rosmarinic, and gallic acid, chia seeds are also referred to as functional foods, super seeds, or golden seeds (Grancieri *et al.*, 2019). Those who are allergic to gluten can utilise chia seeds since they have storage proteins that are higher in globulin fraction and very low in glutenin. Additionally, the seed coat's high mucilage content protects all the nutrients and improves water retention.

Nutritional value of 100 grams chia seeds is as below:

Energy: 486 kcal

Carbohydrates: 42.12 grams

Water: 5.8 g in 100 g dry seeds

Cholesterol: 0 mg

Dietary fibres: 34 g. Chia seeds are exceptionally high in dietary fibers, containing both soluble and insoluble fibers. Insoluble fibres are more than soluble one and are crucial for intestinal health. Chia seeds contain four to five times more fibre than soy, almond, and amaranth, and twice as much as bran (Marcinek & Krejpcio, 2017). Soluble fibers make up most of the gel or mucilage that results from adding water to chia seeds and helps in regulating blood sugar, cholesterol and colon health by increasing bulkiness of faeces (Grancieri *et al.*, 2019; Rahim *et al.*, 2021).



Fat: 30.74g. Chia seeds are also known as oil seeds and are low in saturated fat and high in polyunsaturated fat. (Porrás Loaiza *et al.*, 2014). It has 3.330g of saturated fat, 0.140g of trans fat, 2.309g of monounsaturated fat, 23.665g of polyunsaturated fat and 17.830g of omega 3.

Protein: 16.54g. The proteins in chia seeds are rich in excellent quality amino acids, the essential amino acids are present in primary sequence. Storage proteins fractions show that chia seeds have more globulin fraction followed by albumin, prolamin and glutelin. They are therefore a great source of protein for vegans and vegetarians.

Vitamins: Vitamins and minerals present in 100g dried chia seeds. (Kulczyński *et al.*, 2019)

Vitamins	Quantity	% DV	Minerals	Quantity	%DV
Vitamin A	54 µg	7%	Calcium	631mg	63%
Vitamin B1(Thiamine)	0.62mg	54%	Iron	7.72mg	59%
Vitamin B2 (Riboflavin)	0.17mg	14%	Magnesium	335mg	94%
Vitamin B3 (Niacin)	8.83mg	59%	Manganese	2.72mg	130%
Vitamin B9 (Folate)49	49 µg	12%	Phosphorus	860mg	123%
Vitamin C	1.6mg	2%	Potassium	407mg	9%
Vitamin E	0.5mg	3%	Zinc	4.58mg	48%
			Sodium	16mg	1%

Bioactive compounds: Chia seed is a good source of antioxidants. They have polyphenols, chlorogenic and caffeic acid, myricetin, quercetin and kaempferol. They protect seed delicate fats and have numerous health benefits such as lowering the BP, they neutralize the free radicals and help to protect our heart, liver and have anticancer properties (Cholewski *et al.*, 2018).

V. HEALTH BENEFITS

Chia seeds are very nutritious and offer a variety of health advantages.

1. Aid in Weight Loss: Chia seeds are a helpful tool for managing weight because of their combination of fibre, protein, and healthy fats, which can help increase fullness and lower hunger. By adding chia seeds to meals or snacks, people may feel satisfied for longer, which could result in a decrease in caloric consumption and possible weight loss.

2. Lower Risk of Heart Disease: Rich in soluble fibre and Omega-3 (ALA), chia seeds help lower blood levels of LDL (bad cholesterol) and raise levels of HDL (good cholesterol), improving the blood's good-to-bad cholesterol ratio ((Holscher, 2017). . It has also been discovered that chia seeds can lower levels of oxidative stress, high blood pressure, and high triglycerides—all of which are cardiac risk factors. Omega-3 to omega-6 fatty acid ratios are better in chia seeds, which is good for inflammation and heart health (Enes *et al.*, 2020). The findings showed that supplementing with chia seed oil altered the lipid profile in the liver and adipose tissue, lowering the levels of triglycerides, hepatic cholesterol, and leptin (Citelli *et al.*, 2016).

3. Bone Health: By increasing bone mineral density, chia seeds promote bone health.

4. Lower blood sugar: Chia seeds' rich fibre and nutritional content may enhance insulin sensitivity and aid with blood sugar control. Chia seeds can lessen blood sugar increases that occur after eating a meal high in carbohydrates.

5. Promotes a healthy digestive tract: Chia seeds are a great source of dietary fibre, which is necessary for a healthy digestive system. Constipation can be avoided, regular bowel movements can be encouraged, and the growth of good gut bacteria can be supported by fibre. Eating chia seeds can ease digestive problems and improve gastrointestinal health in general.((Knez Hrnič *et al.*, 2020).

6. Anticancer property: Packed with antioxidants, chia seeds protect against cancer. (Melo *et al.*, 2019) (De Falco *et al.*, 2017).

7. Encourage hydration: Chia seeds soaked in water help the body stay hydrated. Mucilage formed in chia seeds due to soluble fibers can hold large amount of water (Lazaro *et al.*, 2018).

8. Anti-inflammatory effect: Chia seeds have an anti-inflammatory impact since they contain caffeic acid.

9. Skin Health: By encouraging hydration, lowering inflammation, and guarding against oxidative damage brought on by free radicals, the omega-3 fatty acids and antioxidants present in chia seeds may be beneficial to skin health. By adding chia seeds to our diet, we may decrease acne, increase skin elasticity, and postpone the onset of ageing.

RECIPES WITH CHIA SEEDS:

Dosage: Two teaspoons daily

As was previously mentioned, chia seeds are nutrient-dense and offer numerous health advantages. Chia seeds are relatively simple to eat; they can be consumed raw as whole seeds, as flour, fried, or soaked in water. We can add soaked seeds to salad dressings, veggies, yoghurt, smoothies, juices, shakes, puddings and muesli. Eggs can be replaced in baked goods with a jelly made from seeds soaked in water.

Chia seeds are easy to store and use because they last a long time and don't need to be refrigerated. Chia seeds are mildly nutty and remarkable in that they can absorb liquid and turn it into a gel-like consistency. They also have a mild, neutral flavour. Because of this, they can be used in a wide range of recipes, such as savoury meals, smoothies, puddings, and baked products. Some other nutritionally rich seeds could be less adaptable in some recipes due to their greater flavours or textures. We can add chia seeds in following recipes:

- 1. Smoothies:** To enhance the nutritional value and texture of smoothies, incorporate chia seeds into them.
- 2. Cereal or Muesli:** To add crunch and nutritional value, sprinkle chia seeds over cereal, oats, or yoghurt.
- 3. Baked Goods:** To add extra nutrients to muffins, pancakes, and bread, use chia seeds in place of eggs in baking recipes.
- 4. Salads:** To add some nutrition, sprinkle chia seeds on top of salads or incorporate them into salad dressings.
- 5. Puddings:** To make chia seed pudding, mix the seeds with milk or a substitute, sugar, and flavorings like vanilla extract or chocolate powder. Place it in the fridge and let it solidify.
- 6. Beverages:** To make a cool and hydrating drink, mix chia seeds into water, juice, or other drinks. It is important to drink lots of water when consuming them because they absorb water and might expand in the digestive track if ingested dry, which could cause pain. Although chia seeds are safe to consume but if anyone has certain medical issues or allergies should speak with doctor before consuming it. Similar to chia seeds, flax, sunflower, pumpkin, sesame, and hemp seeds are a few types of seeds and plants that provide nutritional advantages. Including a selection of nuts and seeds in our diet can offer a multitude of nutrients and improve our general health and wellbeing.

VI. CONCLUSION

Salvia hispanica, or chia, seeds have amazing physical characteristics and are incredibly nutritious. Chia seeds have higher convergences of beneficial unsaturated fatty acids, gluten-free proteins, nutrients, minerals, phenolic compounds and are good for the digestive system and the management of diabetes ((Ullah *et al.*, 2016). Including chia seeds in the diet can improve overall wellness and health, and more investigation is needed to see whether they have therapeutic uses in the treatment and prevention of certain illnesses. Components of chia seeds may be added in the future to enhance the nutritional content and shelf stability of a variety of food products, including meat and bakery goods.

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