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A Review on Chia Seeds: *Salvia hispanica*

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ABSTRACT

Chia seeds (obtained from plant *Salvia hispanica*; *Lamiaceae* family.) are referred to be the superfoods in the health community. These seeds are rich in protein, dietary fibers, omega 3 fatty acid, flavonoids, polyphenolic compound, Vitamin C&K. Minerals like potassium, manganese, copper, calcium, magnesium also contribute toward its nutritional profiling. It's oil is rich in several bioactive compounds namely quercetin, kaempferol, myricetin, cholorgenic acid & 3,4-dihydroxyphenyl ethanol- elenolic acid di-aldehyde (DHPEA-EDA) .Study showed that chia seeds exhibited anti-inflammatory, anti-cancer, anti-hyperglycemic, anti-oxidant properties.

Keywords: Chia seeds, *Salvia hispanica*, Super food, Omega 3-fatty acid, polyphenolic compound, antioxidant.

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INTRODUCTION

Chia seeds are native to Mexico and Northern Guatemala. It is an annual herb plant [1]. A temperature of 15-30° C and high rain fall is considered the favorable condition for development of plant [2]. The maximum height of the plant is 1 m. It has opposite leaves, which are 4-8 cm long and 3-6cm wide [3]. The flowers are purple or white and sized 3-4 mm. They grow in whorls on top of shoots. The fruit (schizocarp) consist of oval seeds, which are about 2 mm in length. The seeds are mottle-coloured with brown, grey, and black and white [4, 5].

Chia seeds gained its popularity in recent time only, despite being the oldest staplesin the Aztec and Mayan diets. Consumers are adding chia seeds to baked goods, breads, smoothies or simply sprinkling on top of salads, cereals and soups. Chia seeds are added to a wide variety of sweet dishes due to light flavor. Chia seed has a high nutritional potential. Chia seeds contain protein, fat, carbohydrates, dietary fibre. Chia seeds also good source of minerals (calcium, phosphorus, potassium and magnesium), vitamins (thiamine, riboflavin, niacin, folic acid, ascorbic acid and vitamin A) and antioxidant compounds [4,5]. The energetic value of chia seeds is 459-495 kcal/100g [6, 2]

Phytochemical screening and dietary evaluation revealed the presence of tannins, saponins, flavonoids, alkaloids, proteins, cardio glycosides, phenols in the crude extract of Chia seeds [7].

Classification: [8]

Table: 1

Kingdom	*Plantae*
Subdivision	*Spermatophyta*
Order	*Lamiales*
Family	*Lamiaceae*
Genus	*Salvia*
Species	*Hispanica*

Used Parts [8]

Leaves and seeds are mainly use in herbal medicine.

BENEFITS OF CHIA SEEDS.

Anti-hyperlipidemic and anti-hypercholesterol

In one of the experiment on rats, where chia seeds were included in the diet. They showed a reduction in dyslipidemia and visceral adiposity[9,10].Chia seeds also reduced their triacylglycerol levels thereby increasing HDL cholesterol and linolenic.

When different blend of chia seeds and oils was included in the diet of obese Wistar rats, they showed a reduction in oxidative stress and also a reduction in stearoyl-CoA desaturase-1 products from the heart, liver and the adipose tissue of chia seed-supplemented rats was witnessed [11, 12].

In a separate study, dietary chia seeds prevented the onset of dyslipidemia and insulin resistance (IR) in the rats fed with the sucrose-rich diet. Chia seeds oil also reduced adipocyte hypertrophy, lipolysis and the anti-lipolytic action of insulin among high sucrose rats [13, 14].

The combination of different staple seeds mixtures has shown to increase PUFA levels in plasma and liver of experimental animals.

Hypolipidemic and immune modular effects attributable to ALA especially for antioxidant capacity of unsaturated fatty acids is present in seed mixture [15, 16].

Anti-diabetic activity

A few reports showed the potential benefits of chia against the risk factors for Type 2 diabetes on test animals [17]. In one of the study, type 2 diabetic animals consuming chia on a daily basis

(37g/d) exhibited lower blood pressure, lower pro-inflammatory markers and coagulation factors [10].

In another study, there was a substantial reduction in waist circumference of healthy individuals after a month of Chia supplementation without any impact on body weight, suggesting a specific loss of fat mass.

In a traditional treatment system, dietary chia seed reduced the visceraladiposity and insulin resistance among sucrose-induced diabetic rats suggesting its role in lipid and glucose homeostasis [10, 18]. In a separate study, chia enriched diet-modulated dyslipidemia, liver TAG, fatty acid oxidase, acetyl-coA carboxylase and glucose-6phosphate dehydrogenase.

Protein levels of PPAR increased and the increased mature form of SREBP-1 (Sterol regulatory element binding protein-1) levels in the sucrose-rich diet (SRD) was optimized by chia. This study attributed some key mechanisms to the biological effects of dietary chia seed in preventing and normalizing/improving dyslipidemia and liver steatosis in aninsulin-resistant rat model [19].

Anti-cancer property

Dietary PUFAs play an important role in various forms of human cancers [20]. Several studies demonstrate the cytotoxic ability of PUFAs against different types of cancer cells and act in synergy with current chemotherapeutic drugs [21].

Arachidonic acid (20:4, n-6) derived from ALA induces apoptosis of tumor cells by converting sphingomyelin to ceramide that triggers the release of pro-apoptotic Proteins [22] and eicosanoids derived from AA act as active carcinogens or tumor promoters in view of their pro-inflammatory actions and thus participate in cancer development [23].

Moreover, peanut oil rich in linoleic/oleic and their derive PUFAs protects against murine mammary cancer development by modulating tumor membrane fatty acids composition, lipoxygenases (LOX) and cyclooxygenase (COX) enzyme [24].

Hence, it is hypothesized that chia seed oil contains all the derivative of α-linolenic, Linoleic/oleic in good balance may produce the same effect.

Anti-inflammatory property

The inflammatory disorder is associated with pain, redness and swelling. Severity of which leads to loss of vital functions. An interdependent chain of reactions are mediated by inflammatory molecules released from leukocytes. The key inflammatory mediators inclusive of linoleic and its derived eicosanoids, prostaglandin E2 and leukotriene B4 are derived from arachidonic acid. However, lower risks of pro-inflammatory reactions are demonstrated with Chia seed oil diet [24, 25]. The n3 PUFA in Chia seed oil are suggested to compete with arachidonic acid for the

incorporation into the membrane. Hence, generate slightly modified prostaglandins and eicosanoids viz., LTE5, LTB5, and PGE3 which induce lesser extent of inflammation via reduced induction of COX-2 [25].

Anti-oxidant activity

Chia seed and oil is an excellent source of antioxidants such astocopherols, phytosterol, carotenoids and phenolic compounds, chlorogenic acid, caffeic acid, myricetin, quercetin and kaempferol [26-27, 28].Among obesity model of rats, dietary chia oil induced the expression of HSP70 and HSP25 in skeletal muscle and restored superoxide dismutase and glutathione. peroxidase expression [18].

Chia seed oil extraction

(a) **Compression method**: Pressing the seeds at 4°C or 25°C in absence of light, which result in preservation of antioxidant contents. In this method, Oil recovery is limited [26, 27].

(b)**Solvent extraction involves Soxlet method**: Organic solvents for e.g. hexane is used. Functional characteristics like absorption capacity and emulsifying stability are improved. This method is least preferred as it poses health issues from the use of organic solvent [26,27].

(c)**Supercritical fluid extraction:** It is the most preferred method. It use carbon dioxide at 80°C resulting in a better purity of ALA. The yield is increased by inducing high pressure [26-29].

Table: 2: Phytochemical Screening of Chia Seeds [30]

S.No.	Contents	Sample
1	Tanins	+
2	Saponin	+
3	Flavonoids	+
4	Alkaloids	+
5	Protein	+
6	Quinones	-
7	Terpenoids	-
8	Cardiac glycosides	+
9	Phenols	+

Table: 3: Secondary metabolites [30]

Particulars	Extract of ethanolic chia seed
Total phenolic content (mg/g)	76.32 ± 0.22
Total flavonoids (mg/g)	38.25 ± 1.18
equlvalent) 38.25 ± 1.18	190.62 ± 1.29

Structure of Chia Seeds

In the aqueous substance, chia seeds tend to exude polysaccharide mucilage (4.5% dry weight) that remains tightly bound to the seed. This polysaccharide is identified to contain D-xylosyl, D-glucosyl and 4-O-methyl-α-D-glucopyrranosyluronic acid in ratios of 2:1:1 in a

Lineartetra saccharide sequence.

A lower content of uronic acid is an indicator of no pectin being associated with this polysaccharide [27].

Chia seed meal (defatted residue) contains nearly 34% dry weight of fibers and 17% dry weight of protein [31]. The primary component of the insoluble fraction is lignin (39-41%) which protect the unsaturated fats in the chia seed by building a strong and resistant structure. The seed cell wall also contains the general components, cellulose, and hemicellulose [27]. The water holding capacity was 15.41g/g fiber. The high water-holding capacity is due to polysaccharide mucilages [32].

However, the oil-holding capacity of chia seeds is low, (2.02g/g sample). It is hypothesized that the particle size of the fiber fraction is not small enough to hold higher amounts of oil (since smaller particles present more surface area).Chia seed fibrous fraction possesses emulsifying property, (53.26 ml/100 ml), attributed to the protein fraction because most proteins are strong emulsifiers. These emulsifying properties are significant to the absorption of bile acids and increasing fecal excretion, which would limit small intestine uptake [32].

The total chia seed phenolic content around 0.9211 and 0.008 mg/g (GAE gallic acid equivalents) and flavonols were found to be in the highest concentrations. The antioxidant activity measured as radical scavenging activity of chia seeds is comparable to TroloxR at 185-210 ppm GAE.

Chia seed extracts demonstrated metal-chelating potential against iron and copper-induced free radicals [27].

Physiochemical Properties and Applications In The Food Industry [33]

The physical properties of chia seeds have been studied by many researchers. The mean moisture content of white seeds is 7.2 percent while that of black seeds is 6.6 percent.

Moisture has a great effect on the structure and physical properties of chia seed

Table 4 gives the moisture density related physical properties of chia seeds.

Physical property	Black seeds	White seeds
Bulk density (g cm)	0.772	0.667
True density (g cm)	1.009	0.999
Porosity (percent)	28.2	33.1

Nutritional Composition of Chia Seeds

Chia seeds contains Fiber, Protein, Fat, Calcium, Manganese, Magnesium, Phosphorus. They also contain a decent amount of Zinc, Vitamin B3 (Niacin), Potassium, Vitamin B1 (Thiamine) and Vitamin B2. This single ounce, supplies only 137 calories and one gram of digestible carbohydrate. If you subtract the fiber, which may not end up as usable calories for the body, chia seeds only contain 101 calories per ounce.

Chia seeds are loaded with Antioxidants [(34)]

These antioxidants protect the sensitive fats in the seeds from going rancid. Although antioxidant *supplements* are not very effective, getting antioxidants from *foods* can have positive effects on health. Most importantly, antioxidants fight the production of free radicals, which can damage molecules in cells and contribute to aging and diseases like cancer [(35)].

Contain Fiber

Fiber do not raise blood sugar, hence it will not be counted in carbohydrate. This makes chia a low-carbohydrate friendly food. Chia seeds can absorb up to 10-12 times their weight in water, becoming gel-like and expanding in your stomach (32).

Theoretically, this should increase fullness, slow absorption of your food and help you automatically eat fewer calories.

Chia seeds contain a decent amount of protein.

By weight, they are about 14 percent protein. They also contain a good balance of essential amino acids, so our bodies should be able to make use of the protein in them [(36, 37)].Chia seeds are an excellent source of protein for vegetarians.

Help with weight loss

The fiber absorbs large amounts of water and expands in the stomach, which should increase fullness and slow the absorption of food [(38)].Unfortunately, when the effects of chia seeds on weight loss have been studied, the results have been rather disappointing. Although one study showed that chia seeds can reduce appetite, no significant effect on body weight is mentioned yet [(39)].

Omega-3 fatty acids

It is important to keep in mind that omega-3s are mostly ALA (alpha-linolenic acid), that needs to be converted into "active" forms, EPAs and DHAs, before they get absorbed & used by the body. Unfortunately, humans are unable to convert ALA into active forms. Therefore, plant omega-3s are very weak compared to the animals such as fish [(40)].In order to get the DHA either eat fatty fish regularly or take fish oil.

Importance in Bone Strengthening

Chia seeds are high in several nutrients that are important for bone health. This includes calcium, phosphorus, magnesium and protein. It is considered an excellent source of calcium for people who do not eat dairy products.

Remedial uses in Type 2 Diabetics

In this study, 20 diabetic patients received either 37 grams of chia seeds, or 37 grams of wheat bran, for 12 weeks [41].When they got the chia seeds, they saw improvements in several important health markers. Blood pressure went down by 3-6 mm/Hg and an inflammatory marker called hs-CRP went down by 40 percent. A risk factor called vWF also decreased by 21 percent.

NUTRITIONAL ANALYSIS SUMMARY (PER 100g of CHIA SEEDS)[43]

Energy	486Kcal	Calcium	631 mg
Protein	16.54 g	Iron	7.72 mg
Carbohydrate	42.12 g	Magnesium	335 mg
Fiber	34.4 g	Sodium	16 mg
Omega fatty acid	17.82 g	Potassium	407 mg
Total phenolic compound	94 mg	Zinc	4.58
Vitamin A	54 IU	Phosphorous	860 mg
Vitamin E	0.50 mg	Vitamin c	1.6 mg
Fat	30.74 g		

CONCLUSION

Global awareness of public health has increased the need for finding functional food with many health benefits. In the present scenario, the use of medicinal food received from people and tribal food is relevant to prevent degenerative diseases. Chia seeds are not new to mankind. They have been used even in the pre-colombian time by Aztecs as foodstuff and in religious ceremonies. Chia seeds are an excellent source of dietary fiber (insoluble and soluble), omega-3 fatty acids, proteins and bioactive compounds or phytochemicals. Chia possesses many important physiochemical and functional properties which makes it more suitable in the food industry. Chia acts as a good thickener, gel former, chelator, foam enhancer, emulsifier, suspension formers, clarifying agent and as a rehydrating agent. Therefore it can be used commercially for the development of new products enriched with omega-3, protein, soluble/insoluble fiber and phenolic compounds. Chia seeds may help in the prevention, treatment and management of several non-communicable diseases, improving immunity and perhaps modifying the blood clotting mechanism. Chia also helps in improving the post-prandial blood glucose levels in blood by slowing down the digestion of carbohydrates. It can be incorporated in frozen products,

bakery, beverages, sweets, baby foods, pasta, sausages etc. Researches done in vivo and vitro have supported the fact that that it is safe for human consumption and also exhibits wide range of health benefits. There is scope for research on chia seeds with respect to the food industry and nutraceuticals. Chia can thus be considered as a functional food which could help in improving the health of the masses

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