

Flax and chia seeds: a Potent Nutritional Food

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ABSTRACT:

In current day there is a much interest in phytochemicals as bioactive constituents of food. Functional foods are gain prominence in the field of food science due to their increasing popularity among health cognizant people. Flaxseed is being grown in many parts of world for its fiber, oil, also for medicinal purposes and also as nutritional product. The superior nutritional, nourishing.phytochemical composition and therapeutic potential of chia seed drives its increased utilization in industries. This contribution aims to provide an overview of the potential applications of chia seed and the flax seeds in various sectors of health and nutrition. Examples are presented to utilize this forgotten seed in promoting health and nutrition of community. Dietary fibers and high amount of phytochemicals could be an effective health promoting factors. In this article, nutrients, functional properties, and health benefits of bioactive molecules of flax seeds and chia seeds are discussed.

I. INTRODUCTION

Flax seed (*Linum usitatissimum*) commonly known as linseed is a member of the genus *Linum* in the family *Linaceae*. Flax is an oldest agronomic crop having more than 300 species and which are cultivated for food and fiber since ancient times. Flax seed is recognized either by variety or by color (brown and yellow). Brown colored flaxseed is the most common and high in alpha-linolenic acid, while there are two types of yellow colored flaxseed: Omega and *Linola* (Conforti and Cachaper, 2009). Flaxseed is

often used to describe flax when consumed by humans while linseed denotes when it is used specifically for industrial applications.¹ It is popularly known as *Alsi*, *Jawas*, *Aksebija* in Indian languages.² The Latin name of the flaxseed is *Linum usitatissimum*, which means "very useful".³ Flaxseed has been the focus of increased interest in the field of diet and disease research due to the potential health benefits associated with some of its biologically active components. Flaxseeds have nutritional characteristics and are rich source of ω -3 fatty acid: α -linolenic acid (ALA), short chain polyunsaturated fatty acids (PUFA), soluble and insoluble fibers, phytoestrogenic lignans (secoisolaricresinoldiglycoside-SDG), proteins and an array of antioxidants health imparting benefits in reducing cardiovascular diseases, decreased risk of cancer, particularly of the mammary and prostate gland, anti-inflammatory activity, laxative effect, and alleviation of menopausal symptoms and osteoporosis.

Chia (*Salvia hispanica* L.) is a small seed that comes from an annual herbaceous plant, *Salvia hispanica* L. In recent years, usage of Chia seeds has tremendously grown due to their high nutritional and medicinal values. They have been valued in high rank due to their superior nutritional properties such as lipid content, polyphenols and high fibers. Chia seeds are among the nutritional dense foods containing superior quality of omega-3 fatty acids, gluten-free protein and high content of anti-oxidants protecting seeds against microbial and chemical degradations



FLAX SEED



CHIA SEED

Nutritional composition of flax seeds and chia seed

Flax seeds:

Flaxseed oil/lipids:

Flaxseed is the richest plant source of the ω -3 fatty acid i.e. α -linolenic acid (ALA)^{4,5} and lignans (phytoestrogens) Flaxseed oil is low in saturated fatty acids (9%), moderate in monosaturated fatty acids (18%), and rich in polyunsaturated fatty acid (73%)⁶ In flaxseed oil, α -linolenic acid is the major fatty acid ranging from 39.00 to 60.42% followed by oleic, linoleic, palmitic and stearic acids.

Proteins

The protein content of flaxseed varies from 20 to 30%, constituting approximately 80% globulins (linin and conlinin) and 20% glutelin⁷ Flaxseed has an amino acid profile comparable to that of soybean and contains no gluten⁸. It also contains peptides with bioactivities related to the decrease in risk factors of CVD⁹. Whole flaxseed, flaxseed meals and isolated proteins are rich sources of glutamic acid/glutamine, arginine¹⁰, branched-chain amino acids (valine and leucine) and aromatic amino acid (tyrosine and phenylalanine)

Dietary fibers

Flax fibers crop is the world's oldest fiber crop. The use of flax for the production of linen goes back at least to ancient Egyptian times. Flax fiber is extracted from the skin of the stem of the plant. Total flax plant is approximately 25% seed and 75% stem and leaves¹² The stem or non-seed parts are about 20% fiber, which can be extracted by chemical or mechanical retting. A flax fiber is a natural and biodegradable composite, which exhibits good mechanical properties and low density. Flax fiber is soft, lustrous and flexible;

bundles of fiber have the appearance of blonde hair, hence the description "flaxen". Flax fibers include both soluble and insoluble dietary fibers. The major insoluble fiber fraction consists of cellulose and lignin, and the soluble fiber fractions are the mucilage gums;¹⁴

Lignans

Plant lignans are phenolic compounds formed by the union of two cinnamic acid residues. Lignans are present in almost all plants¹⁵ Lignans act as both antioxidants and phytoestrogens. Phytoestrogens can have weak estrogen activity in animals and humans. Flax contains up to 800 times more lignans than other plant foods¹⁶. Lignan content in flaxseed is principally composed of secoisolariciresinoldiglucoside (SDG) (294–700 mg/100 g), matairesinol (0.55 mg/100 g), lariciresinol (3.04 mg/100 g) and pinoresinol (3.32 mg/100 g)¹⁷. Besides lignans, other phenolic compounds found in flaxseed are p-coumaric acid and ferulic acid

Minerals

In relation to composition of minerals, the contents of calcium, magnesium and phosphorus are highlighted¹⁸ being that a 30 g portion of the seed constitutes 7% to 30% of the recommended dietary allowances (RDAs) for these minerals. Proximate content of different minerals is shown in Table 1. Its potassium (K^+) content is high and comparable to those of recommended sources such as banana on a dry-matter basis.

Chia seed

Chia seeds contain a high content of fats (30–33%), carbohydrates (26–41%), dietary fiber (18–30%), proteins (15–25%), vitamins, minerals, and antioxidants (wet basis) Chia seeds contain 39% oil (mass of dry seed), which consists up to

68% of ω -3 and 19% of ω -6 fatty acid¹⁹. The ratio between ω -6 and ω -3 fatty acid is 0.3:0.35²⁰

Protein Content

The protein content of chia seeds is around 17%, greater than the protein content in all other cereals (for instance, in corn the protein content is 9.4%, rice is 6.5%, quinoa 14.1%, and in wheat 12.6%)^{21,22,23}. The amount of proteins in chia seeds depends mainly upon environmental and agronomical factors. the chia seeds contain some exogenous amino acids (arginine, leucine, phenylalanine, valine, and lysine) and some endogenous amino acids (glutamic and aspartic acid, alanine, serine, and glycine).²⁰ For example, the content of amino acid serine is 1.05 g/100 g, glutamic acid 3.50 g/100 g, glycine 0.95 g/100 g, alanine 1.05 g/100 g, lysine 0.97 g/100 g, and histidine 0.53 g/100 g.

Fibre Content

The chia seeds contain very high concentration of fiber. It ranges between 34 g and 40 g of dietary fiber per 100 g²¹. In this specific amount, the insoluble fraction (IDF) represents approximately 85–93%, while the soluble fraction (SDF) represents between 7% and 15%²⁰ (Table 4). Reyes-Caudillo et al.²⁴ showed in their research that a high amount of fiber decreases the risk of coronary heart disease, risk for diabetes type 2, and

several types of cancer, and a high amount of dietary fiber in daily meals decreases subsequent hunger.

Minerals

Additionally, chia seeds contain minerals like calcium, phosphorus, potassium, magnesium, and vitamins (A, B, K, E, D, mainly vitamins B1, B2, niacin) (Table 1). The content of calcium, for instance, is greater than in rice, barley, corn, and oats.

Phenolic Compounds

Focusing on phenolic content, dry chia seeds contain 8.8% of phenolic compounds. Besides that, high levels of caffeic acid, chlorogenic acid, quercetin, rosmarinic acid, gallic, cinnamic, myricetin, kaemferol are also reported. Furthermore, isoflavones, such as daidzein, glycitein, and genistein, are found in small amounts. Rahman et al.²⁵ reported that rosmarinic acid and daidzein are the major components found in chia seeds, along with caffeic acid, mycercin, quercetin, etc. Besides, in the same study, vitamins A, B1, B2, and B3 were identified in chia seeds for the first time. The flavonoids quercetin, chlorogenic acid, and caffeic acid are proven to have anti-cancerogenic, anti-hypertensive, and neuron protective effects²⁶.

Nutritional composition of flaxseed and chia seeds

Nutrients	Amount per 100g of chia	
	Amount per 100 g of edible flaxseed	seeds
Moisture (g)	6.5	5.7
Protein (N × 6.25) (g)	20.3	17
Fat (g)	37.1	31
Minerals (g)	2.4	2
Total dietary fiber (g)	24.5	56

Nutrients	Amount per 100g of chia seeds	
	Amount per 100 g of edible flaxseed	
Carbohydrates (g)	28.9	42
Energy (kcal)	530.0	486
Potassium	750.0	407
Calcium (mg)	170.0	631
Phosphorous (mg)	370.0	860
Iron (mg)	2.7	2.5
Vitamin A (µg)	30.0	54 µg
Vitamin E (mg)	0.6	0.5
Thiamine (B1) (mg)	0.23	0.62

Flax and chiseed : A Nutraceutical or functional food

The words nutraceutical and functional food are wrongly interpreted to be one and the same, though there is a difference between the two. A functional food is one which is similar in appearance to a conventional food, consumed as a part of the usual diet, with demonstrated physiological benefits, and/or to reduce the risk of chronic disease beyond basic nutritional functions. While a nutraceutical is a product isolated or purified from foods that is generally sold in medicinal forms, not usually associated with foods²⁷. A nutraceutical can be a part of functional foods while the latter has to provide essential nutrients often beyond qualities necessary for normal maintenance, growth and development. As

flax is consumed in the form of whole/milled/roasted seeds, oil and flour as a food to provide basic nutrition as well as various health benefits in reducing cancer and cardiovascular diseases, lowering LDL-cholesterol and vasodilatory functions, flax can be considered as a functional food. On the other hand, various stable preparations of flax in the form of nutraceutical like neat oil, capsules and microencapsulated powder are available in market. Flax lignans- isolated SDG preparations are also commercially available as a dietary supplement²⁸. Moreover, flaxseeds were also used as cough remedy and to relieve the abdominal pain in the olden days. Therefore, flax can be considered a potential nutraceutical as well as functional food.

Chia can be considered as “functional food” because apart from contributing to human nutrition, chia helps to increase satiety index, prevent cardiovascular diseases, inflammatory and nervous system disorders, and diabetes, among others. Today, chia seed offers a huge potential in the industries of health, food, animal feed, pharmaceuticals, and nutraceuticals, among others, due to its functional components.

Health benefits:

Flax seeds:

Flaxseed has potential health benefits besides the nutrition, due to 3 main reasons: first, due to its high content of ω -3 α -linolenic acid; Second, being rich in dietary soluble and insoluble fibers; and third, due to its high content of lignans, acting as anti-oxidants and phytoestrogens. The health benefits of all ω -3 fatty acids (ALA, EPA and DHA) have been widely reported for several conditions including cardiovascular disease, hypertension, atherosclerosis, diabetes, cancer, arthritis, osteoporosis, autoimmune and neurological disorders²⁹. Flaxseed has also been reported to act as anti-arrhythmic³⁰, anti-atherogenic, and anti-inflammatory³¹ agent in addition to improving vascular function³¹.

Flaxseed has nutritional and functional properties. The presence of bioactive constituents of flaxseeds have the potentiality to reduce the various diseases such as cardiovascular ailments, strokes, diabetes, cancer etc.,³² is evident from various clinical and epidemiological studies. However, flaxseed contains low quantities of adverse healthy compounds such as cadmium, cyanogenic glycosides, inhibitors of trypsin that are commonly removed through thermal and mechanical processes, including cooking in microwaves, autoclaving and boiling.³³ Flaxseed oil is believed to initiate mental and physical endurance by fighting fatigue and controlling aging process. Flaxseed is also mentioned in Ayurveda as atasi having properties like Madhura (balances the skin pH), Picchaila (lubricous) Balya (improves tensile strength or elasticity of the skin), Grahi (improves moisture holding capacity of skin), Tvagdoshahrit (removes skin blemishes), Vranahrit (wound healing) and useful in Vata (skin) disorders including dryness, undernourishment, lack of lustre / glow.

Flaxseed possesses antioxidant and hepatoprotective properties. Several studies advocated the cholesterol lowering benefits of flaxseed meal.^{34, 35, 36} A study on

hypercholesterolemic rats fed on flaxseed chutney supplemented diet (15 %) revealed significant reduction in LDL cholesterol and total serum cholesterol and no change in HDL cholesterol. In CCl₄ intoxicated rats, lipid peroxidation products were neutralized by flaxseed lignans.³⁷ Several clinical studies showed that EPA and DHA play a major role in reducing depression symptoms. During depression or stress pro-inflammatory cytokines such as TNF- α , interferon gamma etc. are produced. Increased of n-6 fatty acid to n-3 fatty acid ratio may lead to the production of pro-inflammatory cytokines which causes depression and mood swings in elderly persons.^{38, 39, 40}

Lignans present in the flaxseed plays an important role in preventing various types of cancer specially the hormone sensitive ones. Flax lignans are reported to have antioxidant property which presumably is the main reason of the anticancer activity.^{41, 42} The lower incidences of prostate and breast cancers in Asian men and women compared to European men and women has been speculated to be due to the higher consumption of diets rich in fruits and vegetables.^{43, 44}

Various clinical studies imply that lignans prevent breast cancer by balancing the hormonal mechanisms. The lignans inhibit the aromatase activity in adipose tissue resulting in the circulation of estrogen.^{45, 46}

In postmenopausal women, lignans act as weak estrogens, while at normal estrogen levels, lignans act as estrogen antagonists.^{47, 48} Dietary flaxseed moderately lowers the serum levels of steroid sex hormones which are implicated in development of breast cancer in obese postmenopausal women.⁴⁵

Traditionally, dietary fiber is used for the treatment of constipation, irritable bowel syndrome.^{49, 50} Dietary fiber delays gastric emptying, regulate post prandial blood glucose levels and helpful in prevention of constipation.⁵¹ Flaxseed fiber plays an important role in lowering the blood glucose levels. Studies demonstrated that insoluble fiber slows down the release of sugar in the blood and thus help in reducing blood glucose levels to great extent.^{52, 53} Soluble gum of the flaxseed may be helpful in the prevention of cardiovascular diseases by exhibiting hypocholesterolemic effect.^{54, 55} It was observed that flax fiber enriched drink lowered the cholesterol to a large extent as compared to fiber enriched bread.⁵⁶ However, the consumption of fiber bread increased the fecal fat excretion and maintained proper energy balance. Studies have

shown that the high intake of dietary fibers is beneficial for the prevention of obesity in both men and women.⁵⁷

Chia seeds

1. Chia Seeds Assists in Weight Loss

When you eat food which is rich in protein and fiber, it will lead to weight loss. Fiber present in chia seeds makes you feel full, as it expands after absorbing large volumes of water from your body. They can absorb water up to 12 times their weight.

2. Chia Seeds Enhances Digestive Health

For every 28 grams of chia seeds, you get almost 11 grams of fiber, allowing you to get the required amount of this nutrient from a single serving. The dietary fiber, present in these seeds, has a positive impact on your bowel movement, while giving your stool a healthy appearance.

An interesting thing to note is that chia seeds create a substance which resembles gelatin, after consumption. They form this substance because of the presence of soluble fiber. It improves your digestive health by encouraging prebiotics to grow in your gut.

3. Chia Seeds as a Antioxidants

Studies show that antioxidants fight free radical production in your body. Free radicals are dangerous, as they damage your cells. As a result of this, they can cause diseases like cancer during the later stages of life. Also, they are responsible for ageing and cognitive decline.

The antioxidant content in chia seeds can protect your cells from these dangers. Keep in mind that obtaining antioxidants from natural sources is better than consuming supplements.

4. Chia Seeds Great Source of Omega-3 Fatty Acids

Chia seeds are also rich in omega-3 fatty acids. Therefore, they manage and prevent heart diseases, by reducing blood pressure. It also decreases the fat in your liver, improves joint and bone health, prevents your skin from ageing prematurely, and increases the quality of sleep.

By eating chia seeds, your body gets the required amounts of Alpha Linolenic Acid (ALA). Consume fish oil, DHA supplements, or fatty fish along with them so that your body can convert ALA into its more active and useful forms, DHA and EPA. The researchers found that ALA destroys

cancer cells while keeping the healthy ones out of harm's way.

5. Chia Seeds High Nutrient Density

One of the main reasons why chia seeds are gaining popularity all around the world is because of its high nutrient density. By eating two tablespoons of chia seeds, you get calcium, carbohydrates, fat, fiber, magnesium, manganese, phosphorus, protein, and vitamin A. It also provides small amounts of copper, potassium, and zinc.

6. Chia Seeds Improves Dental Health

Nutrients such as zinc, phosphorus, calcium, and vitamin A are great for your teeth. The presence of calcium in chia seeds helps strengthen your teeth, making them great for dental health. Also, due to its antibacterial effects, the germs responsible for bad breath cannot sustain themselves. Phosphorus and vitamin A keep your mouth healthy and add to the strength of your teeth.

7. Chia Seeds Improves Bone Health

A single serving of chia seeds can account for about 18% of your daily calcium requirements. This mineral is an important nutrient for bone health, as it maintains their mass and strength. They also contain boron, which further improves your bone health. It is responsible for metabolising phosphorus, magnesium, calcium, and manganese, which promotes healthy growth in your bones.

8. Chia Seeds Prevents Spike in Sugar Levels

Chia seeds are a great source of fiber, due to which your body doesn't need to increase the amount of blood sugar to digest them. As a result of this, your pancreas doesn't have to increase its production of insulin. When you consume food with high amounts of fiber, it will stabilise your blood sugar.

9. Chia Seeds Improves Cardiovascular Health

According to certain recent studies, dietary fiber can help regulate the immune system and inflammation. Therefore, eating more chia seeds could decrease the risk of inflammation-related conditions such as diabetes, obesity, cardiovascular diseases and cancer. A higher fiber intake has been known to lower blood pressure and cholesterol levels. A review consisting of 67 different controlled trials showed that a modest 10-gram increase in fiber intake everyday reduced LDL or "bad cholesterol", as well as total cholesterol levels in the body. Therefore, the

consumption of chia seeds can help bring cholesterol levels under control.⁵⁸

II. CONCLUSIONS

Based on the information, it is evident that flaxseeds are the richest source of α -linolenic acid and lignans. It is also a considerable potential source of soluble fiber, antioxidants and high quality protein.

The role of flaxseed lignans and ω -3 fatty acid in reducing the risks associated with cardiac and coronary disease, cancer (breast, colon, ovary and prostate) and other human health risk factors has been well known. Flaxseed can contribute in improving the availability of healthy food choices, specifically by improving the nutrient profile of foods through reductions in the salt, sugar and saturated fat content; and by increasing the content of ω -3 fatty acids and other bioactive compounds. The use of flaxseed in whole seed or ground form can be recommended as a dietary supplement.

Chia, *Salvia hispanica* L., is a plant species used since ancient times for dietary and medical purposes. Its products are small dry white and dark seeds. Chia seeds contain a high fat content, carbohydrates, dietary fiber, proteins, vitamins (A, B1, B2, and B3), minerals, and antioxidants. Furthermore, chia seeds contain the flavonoids quercetin, chlorogenic acid, and caffeic acid, which are proven to have anti-cancerogenic, anti-hypertensive, and neuron protective effects. Chia seeds contain antioxidant compounds that reduce the risk of chronic diseases (cancer and heart attack) and offer protection against some disorders such as diabetes, Alzheimer's, and Parkinson's disease. Moreover, the high amount of fiber decreases the risk of coronary heart disease, the risk for diabetes type 2, and several types of cancer. Chia seeds are already used in the food and pharmaceutical industry. In the food industry, chia seeds can be used in different forms: as the whole seed, ground, in the form of flour, oil, and gel. Chia oil is one of the most valuable oils on the market today. The above study states that the flax seeds and chia seeds are a potential nutrient food for a mankind which can be used in daily life as a medicinal food.

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