

Review Article



A Review on Pharmacological Properties and Laboratory Outcomes of Flaxseed Diet (*Linum usitatissimum*)

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ABSTRACT

The current review aimed to provide a comprehensive overview of Bioactive compounds and pharmacological uses, of *Linum usitatissimum*, and to list its significant therapeutic benefits. From various studies, researchers specified the pharmacological properties of flaxseed. The phytoconstituents like lignan and α linolenic acid are the richest of flaxseeds. It is also a chief source for soluble fiber, high-quality protein, and antioxidants. Its long trip from old era to the 21st century from being a medication in old age opened the way for a broad populace. Linolenic acid, linoleic acid, lignans, polysaccharides cyclic peptides, alkaloids, cadmium and cyanogenic glycosides were some of the biologically active chemicals and elements. Flaxseed extracts containing lignan or β linolenic acid were often the focus of biological and clinical research. Some beneficial outcomes for health include decreasing cardiovascular illnesses, atherosclerosis, diabetes, cancer and arthritis, osteoporosis, and autoimmune illnesses, as well as neuroscience. Some Proteins present in flaxseed helps in prevention and cure for cardiovascular disease and reinforce the immune system. This present review focuses briefly on a pharmacological properties and laboratory outcomes of flaxseed diet.

Keywords: *Linum usitatissimum*, α -linolenic acid, soluble fiber, high-quality protein, antioxidants, lignans, Linolenic acid, cyclic peptides, alkaloids, polysaccharides, cadmium, cyanogenic glycosides, cardiovascular illnesses, atherosclerosis, diabetes, cancer and arthritis, osteoporosis, autoimmune illnesses.

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Plant Taxonomy

Kingdom: Plantae

Division: Angiosperm

Class: Eudicots

Sub-class: Rosids

Order: Malpighiales

Family: Linaceae

Genus: *Linum*

Species: *usitatissimum*

INTRODUCTION

The world's oldest harvesting plants include Flax plant as the main crop as it is growing widely from the dawn of civilization. The Scientific name, *Linum usitatissimum* for flaxseed belongs to Latin origin, which indicates "extremely beneficial." Flax was firstly presented to the United States by colonists, who used to design clothes with this fiber. Commercially, most of the components of the flaxseed plant are utilized, either directly or after processing. The stem part of plant produces high-value fibers with excellent strength and sturdiness. Until the 1990s, flax was mostly used to make textiles and paper, though oil of flax seed and its by products are utilized for feeding animals. There is a little distinction between the words linseed and flaxseed. Flaxseed is the one used to call flaxseed whenever people consuming as food, whereas linseed is the one used to call when it is used in industry or for feedstuff. All of these possible health advantages associated with certain of its biologically active constituents, flaxseed has been the subject of considerable study in the area of food and disease research during the last two decades.



Figure 1: Whole plant *Linum usitatissimum*



Flax (*Linum usitatissimum* L.), is the earliest cultivated plant, is a member of the Linaceae family. It's a blue blooming annual plant with little flat seeds that range in color from golden yellow to reddish-brown. Flaxseed has a crisp texture and a nutty flavour. Linseed is another name for flaxseed. Flax is farmed as a commercial or subsistence crop in more than 30 nations around the globe, including all five

continents. Canada is the world's leading flaxseed grower and exporter.¹ India, China, the United States, and Ethiopia are all major flaxseed producers. India is the top flaxseed producer worldwide in terms of acreage, accounting totally for 23.8 %, and in terms of production it is third place, accounting for 10.2 percent of global production.² Flaxseed is mostly grown in Madhya Pradesh and Maharashtra in India.

MORPHOLOGY

Flax plant is a summer annual erect plant with a tap root that grows 20 to 150 cm tall. The blooms are borne in panicle-like inflorescences and are apical.

Leaves: Leaves show Alternate venation, shape of the leaf is linear to linear-lanceolate, 15-55 mm long x 3-13 mm wide leaves.

Fruit: The fruits are spherical, dry capsules with a diameter of 5-9 mm and a seed count of 10 in every huge-seeded oil variant and a smaller amount in fiber kinds.

Seeds: Linseeds are oval in shape and are 3.3-5 mm in length. 1000 seeds weigh anything between 4 and 13 g. Yellow, olive-colour or dark brown coloured seeds are found. Oil and protein are abundant in the endosperm and cotyledons of linseeds from oil variants. The predominant storage type of oil in the endosperm and cotyledons is minute membrane-bound oil structures identified as oleosomes. CLs are found in oleosomes, which may be isolated from other seed components.³

Common Names

Flaxseed, Linseed, Lint Bells (English), La Graine de lin (French), Semilla de lino (Spanish), Semi di lino (Italian), Budhur alkithaan (Arabic), Amani (Japanese), Amassi (Korean), Atasi, Uma (Sanskrit), Alsi, Tisi (Hindi), Javas, Alshi (Marathi), Mashina (Bengali), Hu ma (Chinese).

Nutritional Value

Abundant levels of, dietary fiber, high-quality protein, alpha-linolenic acid (ALA) and phytoestrogens, it has become a popular nutritious meal. Flaxseeds have a 55 % ALA, 35% fiber and 28–30 % protein content.⁴ Flaxseed includes a significant amount of both soluble and insoluble fiber that is 20 percent insoluble fiber and 9 percent soluble fiber, respectively. Flaxseed meal contains necessary amino acids that are comparable in content and composition to those found in soybean.

Nutritional composition of flaxseed

Nutrients	Amount per 100 g of edible flaxseed
Moisture (g)	6.5
Protein (N × 6.25) (g)	20.3
Fat (g)	37.1
Minerals (g)	2.4
Crude fiber (g)	4.8
Total dietary fiber (g)	24.5
Carbohydrates (g)	28.9
Energy (kcal)	530
Potassium	750
Calcium (mg)	170
Phosphorous (mg)	370
Iron (mg)	2.7
Vitamin A (µg)	30
Vitamin E (mg)	0.6
Thiamine (B1) (mg)	0.23
Riboflavin (B2) (mg)	0.07
Niacin (mg)	1
Pyridoxine (mg)	0.61
Pantothenic acid	0.57
Biotin (µg)	0.6
Folic acid (µg)	112

Morris 2007; Gopalan et al. 2004; Payne 2000

Flaxseed as a dietary supplement

1. It's a versatile component that may be found in a variety of foods.
2. One egg can be replaced with 15g of powdered flaxseed in 45ml of water
3. Flax seeds can be used in variety of baked goods.
4. In the case of salad dressings, gum of flax seed (0.45% w/w) can be used to stabilize the emulsion.⁵
5. Flaxseed is also utilized in the feed of animals to rise the nutritional quality of the fat and meat produced by the animals. Commercially accessible omega-3 fortified eggs and pig products are currently accessible.⁶
6. After 6 months of storage, peroxide levels in bread produced with flaxseed oil cake at 10% and 15% were significantly below the threshold limits.⁷
7. This is identified as a good aborticide by Ibn al-Baitar, who mentioned Dioscorides as saying that mixing it with black pepper and honey enhances sexual desire.
8. Linseed poultice is used to treat gouty and rheumatic swellings, as well as coughs and colds when combined with honey.
9. The oil is used to treat pleurisy, pneumonia, and arthritis, as well as other exterior and interior inflammations.
10. Seeds have been utilized to treat IBD in traditional Iranian medicine.



Bioactive compounds

Lignans, Linolenic acid, cyclic peptides, alkaloids, polysaccharides, cyanogenic glycosides, phenolics phytic acid, linatine, trypsin inhibitor, lignans (phytoestrogens), minerals, cadmium vitamins and selenium are just a few of the biologically active chemicals and components found in flaxseed.⁸

Therapeutic uses of flaxseed

1. Flax is good for your colon. It contains anti-cancer qualities and reduces the risk of constipation by acting as a lubricant and an extraordinary source with fiber.
2. Flaxseed supplements can help to improve immunity. In one research, school children who took not more than a teaspoon of flax oil per day had rarer and milder illnesses in respiratory track than school children who did not take flax oil.
3. Flax is good for your heart and circulatory system. Omega-3 fatty acids at ultra-high concentrations reduce LDL (bad) cholesterol levels. Essential fatty acids can also be found in fish oils and algae.
4. Flax contains lipids that are forerunners to mind development. This is exclusively critical throughout different stages of life when an infant's brain develops the fastest, such as through pregnancy and early childhood. During pregnancy and nursing, a wise mother should consider adding a spoonful of flax oil to her regular diet.
5. Flax is good for your skin. Flax oil has been utilized as a dietary supplement in my patients with dry skin, skin that is particularly sun-sensitive or eczema.
6. Flax fat has slimming properties. Essential fatty acid-rich lipids, such as flax, boost the body's metabolic rate, assisting in the burning of extra, harmful fats. When you eat the proper sort of fat, your body has a higher chance of storing the proper quantity of fat. This is known as thermogenesis, a process in which essential fatty acids, particularly gamma-linolenic acid, trigger specialized fat cells throughout the body (known as brown fat) to kick into high gear and burn additional fat (GLA).
7. Flax may help to alleviate the symptoms of diabetes by regulating blood sugar levels.

Flax seed's pharmacology

Flaxseed has newly received interest in the field heart and blood vessel disease since it is the highest known source of both Alpha-linolenic acid (ALA) and phytoestrogen lignans, as well as having a high content of soluble fiber. Flaxseed is made up of a variety of chemical components, the processes of which are still being discovered. Different qualities of the plant, seed, oil, and specific plant components have been assigned in studies. Polyunsaturated lipids such as linoleic acid and ALA are found in plant seeds and oil. Monounsaturated fatty acids,

such as oleic acid, are also present. Both ALA and linoleic acid are necessary fatty acids, which means they cannot be manufactured in the human body and necessity be obtained through dietary sources.⁹ ALA is a predecessor to EPA,¹⁰ and flaxseed consumption has been found to enhance cellular EPA levels linearly.¹¹ The linoleic component of flaxseed, on the other hand, is said to be capable of inhibiting the conversion of ALA to EPA.¹¹ Flaxseed contains a high concentration of lignan secoisolariciresinol diglycoside secoisolariciresinol diglycoside (SDG).¹² Flaxseed contains trace amounts of the lignan matairesinol. Colonic bacteria can transform SDG and matairesinol into 'mammalian lignans' like enterodiol and enterolactone.¹²

Protective impact on the cardiovascular system

Flaxseed has been demonstrated in human trials to lower blood total and low-density lipoprotein cholesterol levels, minimize absorption of postprandial glucose, lower certain indicators of swelling, and elevate serum levels of the omega-3 fatty acids ALA and eicosapentaenoic acid. The cardioprotective long-chain n-3 fatty acids are naturally produced from alpha-linolenic acid. Isoproterenol injections under the skin caused myocardial infarction in rats, according to one research. However, giving flaxseed to neglected rats improved their ECG pattern and biochemical enzyme profiles, indicating that linseed oil can be used to prevent cardiovascular disorders.¹³

Anti-arrhythmic properties

Scientific evaluations reveal that ALA and omega-3 fatty acids found in flaxseeds may have an antiarrhythmic effect.¹⁴ DHA and EPA, but not ALA, was observed to increase antiarrhythmic effects in a concentration-dependent manner in another investigation.¹⁵ In both men and women, higher dietary linolenic acid consumption has been linked to a lower incidence of unusually protracted repolarization.¹⁶

Activity on Blood constituents

Effects on coagulation and platelets, the available evidence on flaxseed's effects on platelet function are contradictory. Flaxseed differs from oils extracted from fishes as it includes up to 20% omega-6- fatty acids and its omega-3 fatty acids must be transformed into eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Flaxseed oil reduced collagen-stimulated platelet aggregation and bleeding time in two trials comparing it to a linoleic acid control (one research in healthy individuals (N=11) and one research in patient role with rheumatoid arthritis (N=22)).¹⁷

Urinary tract activity

The therapeutic effect of dietary flaxseed lignan extract was equivalent to that of routinely used intervention drugs such as 1A-adrenoceptor blockers and 5-reductase inhibitors in BPH individuals.¹⁸



Effects on the mind

Flaxseed improved animal growth and brain development, which might be explained by enhanced omega-3 absorption into these tissues.¹⁹

Natural treatment of bowel syndrome

Cunnane et al. (1995) examined the consequence of eating 50 grams of flaxseed each day for four weeks on a variety of nutrition indicators in ten young healthy people. GI motility, constipation, hypocholesterolemic impact, glucose tolerance and fermentation are all effects of flax fiber that have been thoroughly reported in many reviews and papers.²⁰

Anti-ulcer effect

In the stomachs of guinea pigs and mice, a water extract of whole flaxseed showed a substantial spasmolytic effect and a shielding effect against experimental ulcerogenesis (p 0.01), with effects increasing mutually with increasing soaking time.²¹

Antidiabetic properties

Anti-diabetic properties Flaxseed contains lignans, dietary fibers, and omega-3 fatty acids, all of which have been shown to reduce the incidence of diabetes.²² The phosphoenolpyruvate carboxykinase gene, which codes for a major enzyme involved in glucose production in the liver, has been found to be inhibited by flaxseed lignan SDG.²³ The addition of 10 g flaxseed powder to the diet of type 2 diabetes for a month dropped fasting blood glucose by 19.7% and glycated hemoglobin by 15.6%.²⁴ It might be because flaxseed has a lower glycemic carbohydrate level and a greater dietary fiber content. Numerous small studies employing a fasting glucose tolerance methodology have revealed that women who consume flaxseed had lower postprandial blood glucose levels.²⁵

Effects of hormones

Effects of hormones Plant lignans are abundant in flaxseed (not flaxseed oil).²⁶ Flaxseed and its lignans have been suggested to have powerful antiestrogenic effects on estrogen receptor-positive breast cancer.²⁷ Flaxseed has a high concentration of the lignan secoisolariciresinol diglycoside (SDG).²⁸ Enterolactone and enterodiol (absorbed from flaxseed in the intestine) may block aromatase, 5-alpha-reductase, and 17-beta hydroxysteroid dehydrogenase activity, thereby lowering the risk of prostate, breast, and other hormone-sensitive malignancies.²⁹

Antioxidant properties

Omega-3 fatty acids have been demonstrated as they can reduce the synthesis of interleukin-1, tumour necrosis factor, and leukotriene B4 (LTB4) in neutrophils and monocytes, as well as oxygen-free radicals.³⁰ Lignans can operate as platelet-activating factor receptor opponents, preventing neutrophils from producing oxygen free radicals.³¹ SDG, a flaxseed lignan, has been discovered to

possess antioxidant characteristics.³²

Inflammation/Immune Function Effect

Because of the inclusion of EPA and docosahexaenoic acid, which decrease neutrophil inflammatory responses in humans, flaxseed and flaxseed oil may have anti-inflammatory qualities.³³ These abilities might possibly be due to the inactivation of LTA (leukotriene) epoxide hydrolase, which reduces LB4 and platelet-activating factor-stimulated chemotaxis by inhibiting the production of inositol trisphosphate by the phosphatidylinositol-selective phospholipase C. It has been discovered that ALA reduces arachidonic acid synthesis, resulting in a reduction in inflammation.³⁴ Cell-mediated immunity/T-cell function may be suppressed by ALA without compromising humoral immunity/B-cell activity (made known in immune-compromised ill-patients)

Laxative effect

Due to stretch reflexes, flaxseed (not flaxseed oil) may have laxative properties by raising volume and inducing peristalsis. Flaxseed appears to be unaffected by stomach acid or alkaline conditions in the intestine. Flaxseed has also been suggested to coat and preserve the mucosa of the intestine.

Effect on lipid levels

Flaxseed fiber, which covers D-xylose, L-rhamnose, L-galactose, D-galacturonic acid, and galactose, is thought to have lipid-lowering properties.³⁵ Defatted flax seed (equal to the fiber component of flaxseed) has been shown to dramatically lower total cholesterol, low-density lipoproteins (LDLs), and triglycerides. It has been claimed that the fiber part of flaxseed has lipid-lowering properties through extending stomach emptying time, modifying transit time, interfering with bulk-phase fat transport, and boosting bile acid elimination. Flaxseed is considered to help prevent the formation of atherosclerotic plaques due to the antioxidant effects of lignans and omega-3 fatty acids.³⁰

Effects on the kidneys

Flaxseed enhances citrate excretion and decreases histologic damage in rats with polycystic kidney disease.³⁶ In a mouse model of lupus nephritis, a 14-week diet complemented with 15% flaxseed delays the onset of proteinuria and considerably lowers mortality.³⁷ The anti-inflammatory capabilities of 3 fatty acids have been established in studies to protect kidneys in contrast to injury in adults. In animal models, PUFA supplementation was found to diminish renal inflammation and fibrosis. Increased dietary consumption of long-chain -3 PUFA was inversely linked with the incidence of CKD, according to Baggio et al. 2005 and Gopinath et al. (2011).³⁸ Long-term omega-3 fatty acid supplementation was linked to a Considerable drop in systolic and diastolic blood pressure, according to Cicero et al. (2010). Because hypertension is a risk factor for CKD, the effect of long-chain n-3 PUFA on blood pressure might represent a method by which it



protects the kidneys.³⁹

Laboratory data for flaxseed diet

- Alkaline phosphatase: Using flax seed (rather than flaxseed oil) may lower alkaline phosphate levels. sixty⁴⁰
- Bleeding time: Flaxseed or flaxseed oil might prolong bleeding.⁴¹
- Haematocrit, haemoglobin: Flaxseed (not flaxseed oil) has been shown to boost red blood cell count in animals.⁴⁰
- Serum glucose: A case series demonstrating hyperglycaemia correlated to the ingestion of omega-3 fatty acids (which are contained in flaxseed)⁴³ suggests that flaxseed consumption may cause hyperglycaemia. However, a tiny case study indicated that flaxseed (50g) had no effect on postprandial glucose levels.⁴²
- Serum lipids: Flaxseed or flaxseed oil consumption may lower total cholesterol levels³⁵, whereas flaxseed consumption may lower LDL levels. Although some animal studies reveal increases in triglycerides⁴⁰, human and animal evidence suggest flax seed has triglyceride-lowering properties³¹. Other human research has shown no differences.⁴³
- Serum testosterone, luteinizing hormone (LH)-Flaxseed (flaxseed oil) may theoretically raise serum LH or testosterone levels.⁴⁴

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