



Nutritional Profile of Functional Food - Flaxseed

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Abstract

The nutritive value of flaxseed is unparalleled compared to that of any other seed. Omega-3 fatty acid alpha linolenic acid, lignan secoisolariciresinol diglucoside (SDG), and fibre are all found in abundance in flaxseed. The anti-inflammatory effect, anti-oxidative capability, and lipid regulating capabilities of these chemicals make them useful for animal and human health. Whole flaxseed, ground flaxseed, flaxseed oil, and partially defatted flaxseed meal are the four most frequent forms of flaxseed used for human consumption. Flaxseed has a number of beneficial compounds, including protease inhibitors, phytic acids, linatine, and cyanogenic glycosides. Yet, research on humans has revealed no harmful consequences from these substances. It is possible that the amounts of these components provided by flaxseed in the diet are insufficient to elicit any biological responses. It is, nonetheless, wise to consider the expressed concern. Flaxseed may have its levels of these components lowered by plant breeding or food processing.

Keywords: Cyanogenic glycosides, Flaxseed, Omega-3 fatty acid, Phytic acids

Introduction

The annual herb Flaxseed (*Linum usitatissimum* L.), from the family Lineaceae, with blue or white flowers and produces small, flat seeds of golden yellow to reddish brown color. Flaxseed has a crisp texture and a nutty flavour (Kajla *et al.*, 2015). Flaxseed and linseed are synonyms, both referring to the same plant. Flaxseed is the common name for flax when it is intended for human consumption, while linseed is the term used when it is intended for industrial use. About every component of the linseed plant has a use. Oil extracted from the seeds can be consumed. Fiber may be extracted from the stem, and it is of great quality and very long-lasting. It's been cultivated since it's useful as both a medicine and a food source. The field and seed view of the crop has given in figure 1. More than 50 countries now farm it, mostly in the Northern hemisphere. When it comes to flaxseeds, Canada dominates the global market as the leading exporter. There are a number of countries that grow flaxseed, but a few stand out: India, China, the United States, and Ethiopia. When it comes to land used for growing flaxseed, India is first, accounting for 23.8% of the total. When it comes to output, however, India is third, providing 10.2% of the total (Singh *et al.*, 2011). Area wise, 97% of India is dedicated to flaxseed cultivation in the states of Madhya Pradesh, Chhattisgarh,

Uttar Pradesh, Maharashtra, Bihar, Odisha, Jharkhand, West Bengal, Nagaland, and Assam. It's fascinating to learn that flaxseed originated in India and served as a vital crop there. Flaxseed is still used both as a food and a medicine in India. Because of its many applications, it has earned a high reputation among oilseeds. Flaxseeds have been associated

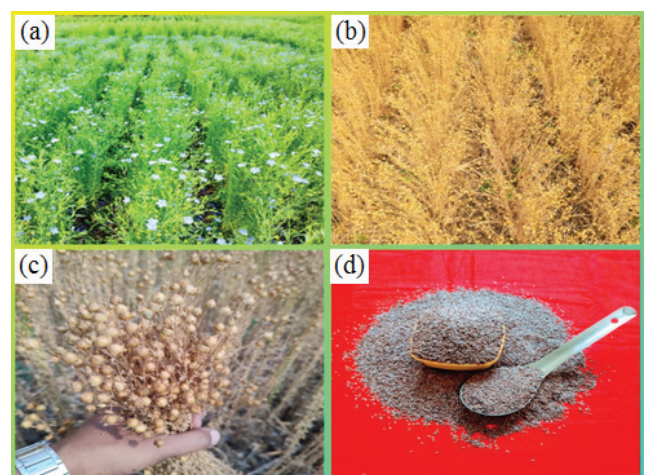


Figure 1: Field and Seed view of Flaxseed: (a) Crop at reproductive stage; (b) crop at mature stage; (c) mature capsules; and (d) seeds

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with numerous health benefits, including those related to digestion and a decreased risk of cardiovascular disease, type-2 diabetes and cancer. The antioxidant activity of brown flaxseeds is slightly higher than that of yellow ones. With its high concentration of beneficial nutrients like alpha-linolenic acid (ALA), fibre, protein, and phytoestrogens, it has gained popularity as a healthful food option. About 55% ALA found in flaxseeds, followed by 28-30% protein and 35% fibre (Rabetafika et al., 2011; Parikh et al., 2019). Nutritionists and medical experts are becoming interested in flaxseed because of the biologically active components it contains, such as alpha-linolenic acid (ALA), lignan-Secoisolariciresinol diglycoside (SDG), and dietary fibre, and the possible health benefits these compounds may have.

Nutritional Status of Flaxseed

There are 534 calories in every 3.5 ounces (100 g) of flaxseeds, or 55 calories in every tablespoon (10 g) of whole seeds. This contains 42% fat, 29% carbs, and 18% protein is what they are made up of. The detail nutritional profile of flaxseed has mentioned in table 1.

Health Benefits of the Nutritional Compounds

Polyunsaturated fatty acids (PUFA) from the omega-3 family, soluble dietary fibres, lignans, proteins, and carbohydrates are only some of the well-known chemical constituents found in flaxseed (Adda, 2019). However, it contains trace amounts of substances that are harmful to human health, including cadmium, protease inhibitors, and cyanogenic compounds. Flaxseed chemical make-up can change according to its genes, growth conditions, seed processing, and analytical technique. The health advantages of various nutritional compounds of flaxseed are discussed below.

1. Health Benefits of Carbohydrate and Fibre

The carbohydrate content of flaxseeds is 29%, almost all of which is present as fibre. They are low in net digestible carbohydrates (carbs minus fibre) and hence qualify as a low-carbohydrate food. In terms of dietary fibre, two teaspoons (20 g) of flaxseeds contain roughly 6 g. That's about 15-25% of a man's or a woman's RDA (Recommended Daily Allowance). 20-40% of the fibre is mucilage gums, and the remaining 60-80% is insoluble fibre (cellulose and lignin). Blood sugar and cholesterol levels are both aided by consuming soluble fibre. As a bonus, it helps your digestive system by nourishing the good bacteria already there. In the presence of water, the mucilage gums in flaxseeds become extremely thick. As flaxseeds also contain insoluble fibre, they are a healthy alternative to laxatives. Flaxseed consumption has been linked to a lower risk of diabetes, improved bowel regularity, and a lowered likelihood of developing the disease.

2. Health Benefits of Protein

Like other vegetable proteins, flaxseed protein has techno-functional qualities that influence its behaviour in a food system as a result of its interactions with other ingredients. For both solubility and water-oil retention, the hydration mechanisms play a crucial role. Protein derived from flaxseeds shares an amino acid profile with soybeans, a plant

Table 1: Nutritional and Chemical Composition of Flaxseed

Sl. No.	Parameters	Value
A.	Fatty acid	(g/ 100 g of flaxseed)
1	α -linolenic acid	22.8
2	Oleic acid	7.3
3	Linoleic acid	5.9
4	Palmitic acid	2.1
5	Stearic acid	1.3
B.	Amino acid	(g/ 100 g of protein)
1	Glutamic acid	19.6
2	Aspartic acid	9.3
3	Arginine	9.2
4	Glycine	5.8
5	Leucine	5.8
6	Valine	4.6
7	Serine	4.5
8	Isoleucine	4.0
9	Lysine	4.0
10	Threonine	3.6
11	Proline	3.5
12	Tyrosine	2.3
13	Histidine	2.2
14	Tryptophan	1.8
15	Methionine	1.5
16	Cysteine	1.1
C.	Carbohydrate	(mg/ 100 g of flaxseed)
1	Neutral arabinoxylan fraction	1.2
2	Rhamnogalacturonan Fraction	0.4
D.	Minerals	(mg/ 100 g of flaxseed)
1	Calcium	236
2	Magnesium	431
3	Phosphorous	622
4	Potassium	831
5	Sodium	27
6	Iron	5
7	Zinc	4
8	Manganese	3
9	Copper	1
E.	Vitamins	(mg/ 100 g of flaxseed)
1	γ -tocopherol	522

Table 1: Continue...

Sl. No.	Parameters	Value
2	α-tocopherol	7
3	δ-tocopherol	10
4	Vitamin C (Ascorbic acid)	0.5
5	Vitamin B1 (Thiamin)	0.5
6	Vitamin B2 (Riboflavin)	0.2
7	Vitamin B3 (Niacin)	3.2
8	Vitamin-B5 (Pantothenic acid)	0.6
9	Vitamin B6 (Pyridoxine)	0.6
F.	Phenolic Compounds	(mg/ 100 g of flaxseed)
1	Ferulic acid	10.9
2	Chlorogenic acid	7.5

protein often considered to be among the healthiest options available. The necessary amino acids are there, but lysine is missing; which means they lack some essential amino acids and are classified as an incomplete protein. Nonetheless, the amino acids arginine and glutamine found in flaxseeds are beneficial to the health of the heart and immune system. Depending on their genetic and environmental backgrounds, flaxseed grain and flaxseed paste can have anywhere from 21 to 34% protein. Typically, seeds grown in cool areas have a high oil content but a low protein level. There are two main types of storage proteins in flaxseed: a salt-soluble fraction with a high molecular weight (11-12S; globulin; 18.6% nitrogen) and a water-soluble basic component with a low molecular weight (1.6-2S; albumin; 17.7% nitrogen). Lysine, Threonine, and Tyrosine are the limiting amino acids in flaxseed, although the ratio of the other essential amino acids is quite favourable. In addition, it contains a healthy amount of branched-chain amino acids and sulphur-containing amino acids (Methionine and Cysteine) (BCAA; Isoleucine, Leucine and Valine).

3. Health Benefits of Fat

About 4 g of fat may be found in every 10 g of flaxseeds, making them a good source of healthy fats. 73% of the fat content is polyunsaturated fatty acids such as omega-6 fatty acids and omega-3 fatty acid alpha-linolenic acid (ALA), while the remaining fat content is formed of monounsaturated and saturated fatty acids, making up the remaining 27%. Because the body is unable to generate ALA, flaxseeds are among the best dietary sources of this crucial fatty acid. Thus, you must get it from the food you eat. Most ALA can be found in flaxseed oil, with ground seeds coming in second. The oil is contained within the fibrous structure of the seed, so consuming the seed in its entirety is the least effective way to obtain ALA. Flaxseeds, which have a higher proportion of omega-3 fatty acids than many other oil seeds, have a lower omega-6 to omega-3 ratio. One study found that people who consumed fewer omega-6 fatty acids in comparison to omega-3 fatty acids had a lower chance of developing many chronic conditions; while fish oils are rich in omega-3, flaxseeds only a fraction of that amount. Furthermore, ALA in flaxseeds must be converted by the

body to EPA and DHA, a process that is typically ineffective. The nutritional value of yellow flaxseed is lower than that of typical brown flaxseed. It's poor in omega-3 fatty acids and has a significantly distinct oil profile.

4. Health Benefits of Vitamins and Minerals

Many nutrients, including vitamins and minerals, can be found in abundance in flaxseeds.

- **Copper:** Copper is a vital mineral required for normal development and growth as well as other biological processes.
- **Molybdenum:** Molybdenum is abundant in flaxseeds. Seeds, grains, and legumes are all good sources of this vital trace mineral.
- **Phosphorus:** This mineral is important for bone and tissue health and is typically present in protein-rich meals.
- **Thiamine:** Vitamin B1 is another name for this B vitamin. Inappropriate levels can disrupt metabolism and neuronal function.

- **Magnesium:** Magnesium, an essential mineral with numerous physiological roles, is abundant in plant foods like cereals, seeds, nuts, and green leafy vegetables.

5. Health Benefits of Other Plant Compounds

Many useful plant metabolites can be found in flaxseeds.

- **Ferulic acid:** This antioxidant shows promise in warding off multiple chronic conditions.
- **Phytosterols:** Plant cell walls contain phytosterols, which are structurally similar to cholesterol. Evidence suggests they help reduce cholesterol levels.
- **Cyanogenic glycosides:** Thiocyanate compounds may be formed in the body when these chemicals are metabolised, and they have been shown to interfere with thyroid function in some persons.
- **p-Coumaric acid:** It is one of the primary antioxidants in flaxseeds, and it is a polyphenol.
- **Lignans:** Phytoestrogens and antioxidants, lignans can be found in a wide variety of plant species. Flaxseeds have as much as 800 times the lignans of any other food. Lignan possesses the following health advantages:
 - ✓ One of the best dietary sources of lignans is flaxseeds. These compounds are both nourishing and protective since they act as phytoestrogens.
 - ✓ Similar to the female sex hormone oestrogen, phytoestrogens are found in plants. Their estrogenic and antioxidant effects are minimal.
 - ✓ They lower blood fat and glucose levels, which have been associated to a lower risk of heart disease and metabolic syndrome. Lowering blood pressure, oxidative stress, and inflammation in the arteries are all benefits of consuming flax lignans.
 - ✓ As a result of their fermentation by intestinal bacteria, lignans may slow the development of numerous malignancies, particularly hormone-sensitive tumours like breast, uterine, and prostate cancer.

Conclusion

Flaxseeds are a promising oil seed option since they have a high concentration of beneficial nutrients. It's useful in a number of forms, including both whole and ground into flour. Breads and pastries made with this flour have a nutty flavour and provide nutritional and health benefits to the consumer. Because to its high polyunsaturated fatty acid (PUFA) and phytosterol content, as well as its low saturated fat level, this oil seed may help reduce total and cholesterol when consumed regularly. Bioavailability of nutrients in flaxseeds is achieved through processing. High-quality protein, fibre, omega-3 fatty acids, and essential vitamins and minerals are all abundant in just one serving of flaxseed. It contains a lot of the B vitamin thiamine, which plays an important function in maintaining healthy cells and converting food into energy. Copper-rich flaxseed also has other benefits, including those related to brain growth, immunity, and iron metabolism. Many studies have demonstrated the protective effects of flaxseed lignans and omega-3 fatty acid against a variety of human health concerns, including cardiovascular disease, cancers of the breast, colon, ovary, and prostate, and more. Taking 1-3 tablespoons of ground flaxseed or one tablespoon of flaxseed oil daily is the standard recommended. In recent years, flaxseed has been included in the ingredients lists of

many baked goods and pastas. Including more omega-3 rich foods and fiber-rich options in one's diet would undoubtedly help. Because of this, flaxseed, either in its whole seed or ground form, can be advised as a supplemental food.

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