



Flaxseed – A Nutrient Primer

Flaxseed has been consumed for centuries for its health benefits. Greek and Roman writings reference the healing powers of flaxseed as far back as 650 BC. In fact Charlemagne, an 8th century emperor, considered flaxseed so important for health that regulations were passed for flaxseed consumption every day.

Flaxseed contains several disease-fighting compounds, primarily the omega-3 fatty acid, alpha-linolenic acid (ALA), fiber, protein and lignans. Canadian flaxseed contains 41% fat, 20% protein, and 28% total dietary fiber¹.

Table 1: Flaxseed Nutritional Analysis²
Nutrients in 2 Tbsp. (16 g)

Calories	72 kcal
Total Fat	6.6 g
Saturated Fat	0.6 g
Polyunsaturated Fat	4.6 g
Linoleic	1.0 g
Alpha-Linolenic	3.6 g
Monounsaturated Fat	1.2 g
Total Carbohydrate	4.6 g
Total Dietary Fiber	4.4 g
Protein	3.2 g
Minerals	
Calcium	56.8 mg
Iron	0.8 mg
Magnesium	62.4 mg
Phosphorus	109.6 mg
Potassium	141.6 mg
Sodium	4.8 mg
Zinc	0.7 mg
Copper	0.3 mg
Manganese	1.3 mg
Selenium	4.3 µg
Vitamins	
Folate	14.8 µg
Niacin	0.5 mg
Pantothenic Acid	0.2 mg
Thiamin	0.3 mg
Vitamin E	11.2 mg
Vitamin K	0.7 µg

¹ Adolphe JL, et al. Br J Nutr 2010;103:929-938.

² Health Canada. 2010. Canadian Nutrient File. <http://webprod3.hc-sc.gc.ca/cnf-fce/index-eng.jsp>

Fat

Flaxseed contains about 6.6 grams of fat per 2 tbsp. serving. Flaxseed is rich in polyunsaturated fatty acids, particularly alpha-linolenic acid (ALA), the essential omega-3 fatty acid, and linoleic acid (LA), the essential omega-6 fatty acid. Both must be obtained from foods because they cannot be made in the body. Approximately 55% of the fatty acids are ALA (3.6 per 2 tbsp. serving) making flaxseed the richest plant source of this critical omega-3. Flaxseed is also low in the nutritionally undesirable saturated fatty acids at less than 9% of total fatty acids. Flaxseed does not contain harmful trans fatty acids¹.

Table 2. Average content of α -linolenic acid in select food sources³

Food item	Average content (%)
Flaxseed oil	55
Flaxseed	23
Hempseed oil	22
Chia seed	18
Walnut oil	10
Walnuts, English	9
Canola oil	9
Soybean oil	7
Corn oil	1
Olive oil	1
Sunflower oil	1
Kale	0.2
Spinach	0.1

To meet the body's requirements, men and women aged 14 years and older should consume 1.6 grams and 1.1 grams of ALA, respectively. One tbsp. (30 mL) of milled flaxseed provides 1.6 g of omega 3 which is slightly more than the daily recommended amount for both men and women⁴.

Most Western diets no longer contain the amount of ALA omega-3s needed for overall health and wellness, and in fact may contain more than 10 times as many omega-6 fatty acids as omega-3. Processed foods contribute to high omega-6 and low omega-3 intakes. Linoleic acid (LA) is the essential omega-6 fat required by the body in moderate, not excessive, amounts. It is the primary fat in soybean and corn oils.

Eating less omega-6 and more omega-3 fats, from foods like ALA-rich flaxseed, can help lower the risk of chronic diseases like heart disease, stroke, and cancer, as well as lower LDL "bad" cholesterol. The research supporting the health effects of ALA is impressive:

³ Rajaram S. Am J Clin Nutr. 2014 Jul;100 Suppl 1:443S-8S.

⁴ Food and Nutrition Board, Institute of Medicine of the National Academies. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington, DC: National Academies Press; 2005.

- *ALA regulates the heartbeat.* ALA can reduce the risk of sudden cardiac death in humans by decreasing the time the heart muscle needs to recover after a heart beat¹⁵ and by maintaining a steady heart beat. In the Nurses' Health Study, women who consumed as little as 1.2 g of ALA daily (the amount found in 2 tsp of milled flax) had a 40% lower risk of sudden cardiac death than women with a low ALA diet.
- *ALA reduces inflammatory reactions.* Clinical studies show that consuming an ALA-rich diet achieves a clinically significant reduction of 18-75% in the concentrations of pro-inflammatory compound such as eicosanoids, cytokines and indicators of whole-body inflammation such as C-reactive protein⁵. A diet rich in ALA significantly decreased markers of endothelial dysfunction including VCAM-1, ICAM-1 and E-selectin compared to an average American diet⁶ while serum level of TNF- α decreased by 43% and immune cell production of TNF- α , IL-6 and IL-1 β , decreased between 18% and 22%⁷.
- *ALA reduces blood pressure:* A 12-week dietary supplementation with 8 g/day ALA resulted in significantly lower systolic and diastolic blood pressure levels compared with LA⁸.

A meta-analysis reported that each 1 g/day increment of ALA intake was associated with a 10% lower risk of death from coronary heart disease⁹. Individuals with low initial ALA intakes may experience the greatest cardiovascular benefits with increased intakes¹⁰. This evidence has led to the recommendation that ALA intake be increased to 2–3 g/d to reduce the risk of CVD¹¹.

Flaxseed contains more than three times as much omega-3 fatty acids than omega-6 fatty acids, with an omega-6 to omega-3 ratio of 0.3:1. When comparing to other common plant based oils, corn oil has an omega-6: omega-3 ratio of 58:1, soybean oil 7:1, and canola oil 2:1. Supplementing the diet with flaxseed provides a high source of the plant based omega-3 ALA, low levels of omega-6 LA as well as a healthy and optimal omega-6: omega-3 ratio.

⁵ Barcelo-Coblijn, G and Murphy, EJ. *Prog. Lipid Res.* 2009; 48(6):355.

⁶ Zhao, G, et al. *J. Nutr.* 2004;134:2991-97.

⁷ Zhao G, et al. *Am J Clin Nutr.* 2007;85:385-391.

⁸ Paschos G.K., et al. *Eur. J. Clin. Nutr.* 2007; 31: 1-6.

⁹ Pan A, et al. *Am J Clin Nutr* 2012;96:1262-1273.

¹⁰ Campos H, et al. *Circulation* 2008;118:339-345.

¹¹ Fleming JA, et al. *Adv Nutr* 2014;5:863s-876s.

Protein

The protein content of flaxseed varies from 20 to 30 %. Flaxseed contains no gluten¹².

Table 3. Protein and amino acid content of select oilseeds¹²

	Flaxseed	Soybean	Chia	Corn, yellow
	g/100 g	g/100 g	g/100 g	g/100 g
Protein	19.29	16.64	16.54	9.42
Tryptophan*	0.297	0.242	0.436	0.067
Threonine*	0.766	0.723	0.709	0.354
Isoleucine*	0.896	0.807	0.801	0.337
Leucine*	1.235	1.355	1.371	1.155
Lysine*	0.862	1.108	0.970	0.265
Methionine*	0.370	0.224	0.588	0.197
Cysteine	0.340	0.268	0.407	0.170
Phenylalanine*	0.957	0.869	1.016	0.463
Tyrosine	0.493	0.630	0.563	0.383
Valine*	1.072	0.831	0.950	0.477
Arginine	1.925	1.291	2.143	0.470
Histidine*	0.472	0.449	0.531	0.287
Alanine	0.925	0.784	1.044	0.705
Aspartic acid	2.046	2.093	1.689	0.655
Glutamic acid	4.039	3.224	3.50	1.768
Glycine	1.248	0.770	0.943	0.386
Proline	0.806	0.974	0.776	0.822
Serine	0.970	0.965	1.049	0.447

*Essential amino acids

The protein found in flaxseed is very similar to that of soybean protein, which is considered one of the most nutritious plant proteins. This is due to the type of amino acids present, which are the building blocks of protein. Whole and milled flaxseed, oil-extracted flaxseed meals, and isolated flaxseed proteins have high levels of glutamic acid/glutamine, arginine, and branched-chain amino acids (valine and leucine) and are low in aromatic amino acids (tyrosine and phenylalanine)¹³. Flaxseed protein is not considered to be a complete protein due to the limiting EAA, lysine¹¹ (Table 2).

The protein in flaxseed can make an important contribution to overall protein intake, particularly for vegetarians or people trying to consume less animal products. In a world that is striving to feed a rapidly expanding population, choosing more plant-based foods is becoming an increasingly popular strategy among health- and environmentally-conscious consumers seeking more sustainable diets.

¹² Oomah BD, Mazza G. *Food Chem.* 1993; 48:109-114.

¹³ U.S. Department of Agriculture. USDA national nutrient database for standard reference. <http://ndb.nal.usda.gov/> 2011.

Dietary Fiber

Flaxseed contains both soluble and insoluble fibers. It contains approximately 28% dietary fiber, with a ratio of soluble to insoluble fiber between 20:80 and 40:60¹. Two tbsp. (30 mL) of milled flaxseed contains 4 grams of fiber, which is 16 percent of the daily recommendation.

The soluble dietary fiber fraction of flaxseed is found primarily as mucilage gums. Soluble fiber forms a “gel” in the stomach that slows the appearance of glucose in the blood and lowers blood cholesterol. For a soluble fiber to be effective, it also must be viscous. Viscosity slows transit of chyme (digested food stuffs) in the upper gastrointestinal tract, resulting in slower absorption rates, especially lipids and glucose resulting in lower blood concentrations of these nutrients¹⁴. Such effects ultimately benefits cardiovascular health as well as reduce the impact of diabetes.

Diets high in insoluble fiber result in good colon health, which may have protective effects against colon cancer. Fiber speeds transit time through the colon and promotes a healthy population of microbiota in the gut. Higher levels of dietary fiber consumption have been correlated with lower risk of colon cancer¹⁵.

Diets high in dietary fiber, both soluble and insoluble types, have demonstrated beneficial effects on weight loss. Studies have shown that high fiber foods, such as flax, deliver more bulk in the diet with less energy, which in turn may influence satiety as well as alter certain hormone responses such as cholecystokinin and insulin¹⁶.

The American Dietetic Association has cited the “significant impact” that fiber can have on the prevention of obesity, cardiovascular disease and type 2 diabetes¹⁷. The Institute of Medicine has set the Adequate Intake for fiber at 14 g per 1000 kcal, or about 25 g/day for women and 38 g/day for men³. Flaxseed provides 4 g, or 16% of the Daily Value for fiber, per 2 tbsp. serving, so it is an excellent option for boosting dietary fiber intake.

Lignans

Lignans are natural antioxidants that reduce the activity of cell-damaging free radicals, slow the aging process, and increase overall wellness. Flaxseed contains up to 800 times more lignans than other plant sources, such as whole grains and legumes. Secoisolariciresinol diglucoside (SDG is the major lignan found in flaxseed and usually contains between 0.7% and 1.9% SDG (1 to 26 mg/g of seed)¹.

¹⁴ Dahl WJ and Steward ML. *J Acad Nutr Diet*. 2015; 115:1861-1870.

¹⁵ Zeng H, Lazarova DL, and Bordonaro M. *World J Gastrointest Oncol*. 2014; 6:41-51.

¹⁶ Slavin JL. *Nutrition*. 2005; 21: 411-418.

¹⁷ American Dietetic Association. *J Am Diet Assoc*. 1997; 97:1157-1159.

Besides acting as antioxidants, lignans are phytoestrogens — active substances derived from plants that mimic the action of estrogen hormones in the body. SDG competes with estrogen and testosterone for binding to their respective receptors, and by inhibiting the enzyme aromatase, which converts androgens into estrogen¹⁸. Non-hormone-related actions of SDG include decreasing nuclear aberrations and genetic damage, cell proliferation and metastasis, and production of growth factors that promote angiogenesis and tumour growth.¹

Lignans may help to reduce menopausal symptoms and could be considered as an alternative to traditional drugs¹⁹. These compounds may reduce the risk of cancers of the breast, prostate, and endometrium. Lignans are especially important for women as they may decrease the risk of breast cancer and reduce the spread and growth of breast cancer after diagnosis²⁰. Lignans also possess anti-inflammatory properties associated with a lower risk of artery-clogging plaques. Lowering the risk of type 1 and 2 diabetes is a positive effect attributed to lignans¹.

Vitamins

Flaxseed contains water- and fat-soluble vitamins. Vitamin E, a fat-soluble vitamin, is present in flaxseed primarily as gamma-tocopherol which functions as an antioxidant. Vitamin E may help prevent or delay coronary heart disease by limiting the oxidation of various serum lipids²¹. Vitamin E also may help prevent the formation of blood clots (thrombosis), which could lead to a heart attack. Observational studies have associated lower rates of heart disease with higher vitamin E intake from food²².

Gamma-tocopherol protects cell proteins, fats and DNA from oxidative damage by free radicals, which may help prevent chronic diseases like heart disease and stroke, and it promotes sodium excretion in the urine, which may help lower blood pressure²³. Flaxseed contains about 0.7 mg/g of total tocopherols of which gamma-tocopherol content averages 0.5 mg/g²⁴.

Minerals

One serving of flaxseed (2 tbsp.) contains 62.4 mg of magnesium, about the same amount as found in a ½ a banana or ½ cup of 2% milk. The potassium content of ground flaxseed is about 142 mg per 2 tbsp. serving or about the same amount of potassium found in row slices of toasted pumpernickel bread or a hard-boiled egg. Flaxseed is also low in sodium.

Flaxseed contains over 4 micrograms of selenium in a 2 tbsp. serving. Selenium is a trace mineral that is incorporated into proteins to make selenoproteins, which are important

¹⁸ Saarinen N, et al. Thompson LU, Cunnane SC, eds. 2nd ed: AOCS Press, 2003;223-231.

¹⁹ Chen M., Lin C. and Liu C. *Climacteric*. 2015; 18: 260-269.

²⁰ Lowcock EC, et al. *Cancer Causes Control* 2013;24:813-816.

²¹ Li G, et al. *Eur J Prev Cardiol*. 2016;23:718-757.

²² Saremi A. and Arora R. *Am J Ther*. 2010; 17:e56-65.

²³ Mazidi M, et al. *Diabetes Metab Syndr*. 2016. doi: 10.1016/j.dsx.2016.12.005

²⁴ Nazim Ciftci O, et al. 2012; *Eur J Lipid Sci Techn*. 2012; 114(7):794–800.

antioxidant enzymes²⁵. The antioxidant properties of selenoproteins help prevent cellular damage from free radicals.

Phytosterols

Phytosterols, also known as plant sterols, are a naturally occurring class of compounds found in the cells and membranes of grains, fruits and vegetables²⁶. Phytosterols have a similar molecular structure to dietary and endogenously secreted cholesterol and are present in foods as beta-sitosterol, campesterol, and stigmasterol.

Because cholesterol and phytosterol molecules are similar, phytosterols can compete with, and block the absorption of dietary cholesterol into the bloodstream. They can also inhibit the re-absorption of cholesterol from the digestive process, thus reducing the amount of cholesterol entering the bloodstream²⁷. Scientific studies indicate that 1.6-3 grams per day of plant sterol esters in the diet can lower blood cholesterol²⁸.

Flaxseed contains 40.72 mg/g of phytosterols in its lipid fraction. Beta-sitosterol is the dominant form representing 35.6% of the total amount.

Flaxseeds have become popular due to their high content of omega-3 fatty acids, fiber, protein and other plant phytonutrients. Science has shown flaxseed to positively affect a range of risk factors, and consumption is associated with improved overall health and wellness.

Flaxseed is found in many foods from crackers to frozen waffles to oatmeal. Flaxseed has a pleasant, nutty taste and along with its unique blend of nutrients, is an excellent addition to the diet. Including flaxseed is a great dietary choice as part of an overall healthy lifestyle.

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²⁵ <http://ods.od.nih.gov/factsheets/Selenium-HealthProfessional/>

²⁶ Racette SB, et al. *J of AOAC Int.* 2015; 98(3):679-684.

²⁷ Moruisi KG., Oosthuizen W. and Opperman AM. *J Am Coll Nutr.* 2006; 25:41-48.

²⁸ Malinowski JM. and Gehret MM. *Am J Health Syst Pharm.* 2010; 67:1165-1173.