Subscription Agency
Exploring and Distributing Knowledge Globally

Journal of Advancement in Pharmacognosy
Volume 4 Issue 1, 2023
ISSN: 2582-8401

A Comprehensive Review on *Linum usitatissimum* Medicinal Plant: Its Phytochemistry, Pharmacology and Ethnomedicinal Uses

Meenaz Siddiquee, Priyanka Pandey, Wasim Raza*
Central Laboratory Facility, Chhattisgarh Council of Science and Technology, Raipur, Chhattisgarh, India

Corresponding Author
Email Id: drwasimraja84@gmail.com

ABSTRACT

Linum usitatissimum or flax has been broadly utilized in numerous milieus worldwide as a primeval medicinal plant because of its health benefits in diverse types of diseases. Objective: The objective of this review is to assemble the latest information on the botanical description, distribution, conventional uses, and biochemical constituents, along with the pharmacological activities and toxicity of flax. One serving of flaxseed provides a good amount of protein, fiber, and omega 3 fatty acids. It may help lower the risk of some cancers, help maintain a health weight, and reduce cholesterol and blood pressure. With its mild, nutty flavor and crisp, crunchy consistency, flaxseed is a versatile ingredient that can enhance the taste and texture of almost any recipe.

One way to use this seed is by mixing it into my morning smoothie. It also makes an excellent addition to pancake batter, homemade veggie burgers, and even overnight oats. What's more, it's loaded with nutrients and linked to numerous benefits. Linum usitatissimum L. is a very valuable crop cultivated for its high dietary nutrients. It is containing substantial quantities of phenolic compounds, mainly lignans, that have several beneficial health effects. Lignans are important plant derived phenols that reduce the risk of prostrate and colon cancers. Its seed, commonly known as flax seed, is a remarkable dietary substitute and a rich source of omega-3 fatty acids (α-linolenic acid), omega6 fatty acids, phytochemicals and phytoestrogenic compounds.

Whole flaxseed, flaxseed oil, lignan precursors, and its mucilage also prevent and treat various diseases and ailments. They not only reduce inflammation, but also regulate blood pressure and reproductive function, maintain the circadian rhythm and prevent the formation of acne. These beneficial effects hence make the flax plant components complete functional food, which when included in the daily diet, will be bestow several health benefits.

INTRODUCTION

Flax is a self-pollinated species with a genome size approximately 370 Mb (Ragupathy et al., 2011). The haploid chromosome number of *L. usitatissimum* is n = 15 (Cloutier et al., 2012). Other species have 8, 9, 10, 14, and 15 pairs (Beard and Comstock, 1965). Colchicine treatments have reportedly caused tetraploidy, phenotypic changes such as sterility and lower yield (Beard and Comstock, 1965), lower seed oil and iodine content (Ross and Boyce, 1946), larger size of petals, pollen grain, seed, and stomata in seed flax, and lower seed size and plant height in fiber flax (Pandey, 1956). World gene banks store approximately 48,000 accessions of flax germplasm (Diederichsen, 2007). In Canada, a world collection of

Journal of Advancement in Pharmacognosy
Volume 4 Issue 1, 2023
ISSN: 2582-8401

approximately 3,500 accessions of cultivated flax is maintained by Plant Gene Resources of Canada (PGRC, 2018).

Common Name(s)

Linum usitatissimum is commonly known as flax when grown for the fibre extracted from the stem and as linseed or oilseed flax when grown for the oil extracted from the seed.

Taxonomy and Genetics

Linum usitatissimum is one of the nearly 230 species of the family Linaceae which comprises about 14 genera. *L. usitatissimum* is an annual herbaceous whose genus *Linum* includes nearly two thirds of the total species of the Linaceae family. Despite this remarkable diversity, flax is the only cultivated species in that family (Bailey 1976; CABI 2018). The USDA-NRCS (2010) taxonomy of flax is as follows:

Kingdom: Plantae (plants)
Subkingdom: Tracheobionta (vascular plants)
Superdivision: Spermatophyta (seed plants)
Division: Magnoliophyta (flowering plants)
Class: Magnoliopsida (dicotyledons)
Subclass: Rosidae
Order: Linales
Family: Linaceae
Genus: *Linum L.*
Species: *Linum usitatissimum L.*

General Description

Flax is an erect, herbaceous annual which branches corymbosely above the main stem (Fernald, 1950). Flax has been a source of food, feed, fiber, and medicine for more than 8,000 years (van Zeist and Bakker-Heeres, 1975). Linseed oil provides health benefits mainly due to its high content in omega-3 alpha linolenic acid (55-57%). Moreover, linseed oil has valuable attributes in paints and varnishes because of its unique drying properties that result from its distinctive fatty acid composition (Przybylski, 2001). The lignans contained in linseeds have been shown to have beneficial properties against breast, colon, prostate and thyroid cancer, and in lowering relative risk factors for heart disease (Westcott and Muir, 2003). Canada is the first country to allow a health-related claim for flaxseed use on food labels, linking ground whole flaxseed to lower cholesterol (Health Canada, 2014).

Health Benefits of Flaxseed

Loaded with Nutrients

Flax seeds may be tiny, but they're chock full of nutrients. A quarter cup—about four tablespoons—of whole flax seeds supplies: (US Department of Agriculture. Seeds, flaxseed). Calories: 224, Fat: 17.5g, Saturated Fat: 1.5g, Unsaturated Fat: 16g, Sodium: 12.6mg, Carbohydrates: 12g, Fiber: 11.5g, or 41% of the daily value (DV), Added Sugars: 0g, Protein: 7.7g, Thiamin: 0.69mg 57% DV, Magnesium: 165mg 39% DV, Selenium: 7.12mcg 19% DV, Iron: 2.4mg 13% DV.

Flax seeds are a great source of thiamin, a B vitamin that helps convert nutrients into energy. Another stand-out nutrient of flax seed is magnesium, which is important for nerve, muscle, and immune function (National Library of Medicine. Magnesium in diet). Meanwhile,

Journal of Advancement in Pharmacognosy
Volume 4 Issue 1, 2023
ISSN: 2582-8401

selenium protects cells from damage or infection (National Institutes of Health. Selenium). And iron helps make red blood cells—which carry oxygen through our bloodstream (National Library of Medicine. Iron in diet).

Flaxseed in Cancer

Studies on the activity of lignans on breast, colon, prostate and thyroid cancer has generally shown beneficial effects although there are some studies with either no conclusive or negative effect. Flaxseed has been shown to reduce the early risk markers for and incidence of mammary and colonic carcinogenesis in animal models (Serrino M, Thompson LU, 1992; Jenab M, Thompson LU, 1996; Serriaino M, Thompson LU, 1991; Thompson LU et al., 1996). Lignans from flaxseed have been shown to reduce mammary tumor size by >50% and tumor number by 37% (Thompson LU et al., 1997) in carcinogen-treated rats. Effect of flaxseed feeding on risk markers of cancer in humans (Phipps WR et al, 1993) demonstrated that the ingestion of 10 g of flaxseed per day elicited several hormonal changes associated with reduced breast cancer risk. Flavanoids, herbacetin 3, 7- Odimethyl ether (Allman MA et al., 1995) and herbacetin (Adlercreutz H et al., 1982), the aglycone of 1, were shown to mediate antioxidant activity which may contribute to the chemopreventive activity of flaxseed (Qiu Sheng-Xiang et al., 1999). Epidemiologic studies have also shown that the prevalence of breast cancer is lower in countries where the diet is vegetarian (Block G et al., 1992; Parkin DM et al., 1992) and that lignin concentrations were found significantly lower in omnivores and in women with breast cancer (Adlercreutz H et al., 1982; Adlercreutz H et al., 1993). Thus, it is becoming increasingly obvious that lignans possess many beneficial properties. Both phytoestrogen and dietary fibre have been shown to have cancer protective effects. Flaxseeds significantly increased urinary excretion of lignans without changing the serum hormone concentration of premenopausal women suggesting that the chemoprotective effects reported for flaxseed may have resulted from mechanism other than a hormonal effect (Frische EJ et al., 2003).

Flaxseed in CVD

Flaxseed has recently gained attention in the area of cardiovascular disease primarily because it is the richest known source of both Alpha-linolenic acid (ALA) and the phytoestrogen, lignans, as well as being a good source of soluble fiber. Human studies have shown that flaxseed can modestly reduce serum total and low-density lipoprotein cholesterol concentrations, reduce postprandial glucose absorption, decrease some markers of inflammation and raise serum levels of the omega-3 fatty acids, ALA and eicosapentaenoic acid. Alpha-linolenic acid is the natural precursor of the cardioprotective long-chain n-3 fatty acids. A 12-week dietary supplementation with flaxseed oil, rich in ALA (8 g/day), on blood pressure in middle-aged dyslipidaemic men resulted in significantly lower systolic and diastolic blood pressure levels (Paschos GK et al., 2007; Ueshima H et al., 2007).

Partially defatted flaxseed reduced total cholesterol (4.6 ± 1.2%; P = 0.001), LDL cholesterol (7.6 ± 1.8%; P < 0.001), apolipoprotein B (5.4 ± 1.4%; P = 0.001) and apolipoprotein A-I (5.8 ± 1.9%; P = 0.005), but had no effect on serum lipoprotein ratios. There were no significant effects on serum HDL cholesterol, serum protein carbonyl content, or ex vivo androgen or progestin activity. Unexpectedly, serum protein thiol groups were significantly lower (10.8 ± 3.6%; P = 0.007) suggesting increased oxidation (Jenkins DJ et al., 1999). Dietary flaxseed has been shown to have potent antiatherogenic effects in rabbits. When LDL receptor deficient mice (LDLrKO) were administered a 10% flaxseed-supplemented diet for 24w, a reduction of circulating cholesterol levels was observed indicating the anti-

Journal of Advancement in Pharmacognosy
Volume 4 Issue 1, 2023
ISSN: 2582-8401

atherogenic effect of flax seeds (Dupasquier CMC et al., 2007). Flaxseed supplementation was associated with significant reductions in TC (-17.2%), LDL-C (-3.9%), TG (-36.3%) and TC/HDL-C ratio (-33.5%). Dietary flaxseed significantly improves lipid profile in hyperlipidemic patients and may favorably modify cardiovascular risk factors. Studies on experimental animals indicated that flax and pumpkin seed mixture had antiatherogenic and hepatoprotective effect probably mediated by unsaturated fatty acids in the mixture (Makni M et al., 2008). Flaxseeds are richest source of lignans that are converted to enterolactone by intestinal microflora. Enterolactone has been suggested to be the prime active compound mediating atherosclerosis protective effects (Fuchs D et al., 2007). Flaxseed regimen reduced serum levels of both low-density and high-density lipoprotein cholesterol by 4.7% and triglyceride by 12.8%. Serum apolipoprotein A-1 and apolipoprotein B concentrations were significantly reduced by 6 and 7.5%, respectively, by the flaxseed administration in postmenopausal women. Markers of bone formation and resorption were not affected by either of the treatments. The flaxseed supplementation thus improves lipid profiles but has no effect on biomarkers of bone metabolism in postmenopausal women (Lucas EA et al., 2002) (Mandaşescu S et al., 2005).

Flaxseed in Nephrology

Flaxseed derivatives, including both oil and flax lignans, modify progression of renal injury in animal models, including Han: SP RD-cy Polycystic Kidney Disease (PKD) (Ogborn MR et al., 2006). Male obese SHR/N-cp rats were randomly assigned to one of three diets containing either 20% casein, 20% soy protein concentrate, or 20% flaxseed meal. Except for the protein source, all three diets were identical and contained similar amounts of protein, fat, carbohydrates, minerals and vitamins. All animals were maintained on these diets for 6 months. All three groups had similar amounts of food intake and body weight gain and exhibited fasting hyperglycemia and hyperinsulinemia. Plasma glucose levels did not differ among the three groups, but plasma insulin concentration was significantly lower in rats fed flaxseed meal than those fed either casein or soy protein concentrate. Mean plasma creatinine, creatinine clearance and urinary urea excretion also did not differ significantly between the three groups. By contrast, urinary protein excretion was significantly lower ($P < 0.01$) in rats fed flaxseed than in rats fed either casein or soy protein concentrate. It's concluded that dietary protein substitution with flaxseed meal reduces proteinuria and glomerular and tubulointerstitial lesions in obese SHR/N-cp rats and that flaxseed meal is more effective than soy protein in reducing proteinuria and renal histologic abnormalities in this model. The reduction in proteinuria and renal injury was independent of the amount of protein intake and glycemic control. Which dietary component(s) present in flaxseed meal is (are) responsible for the renal protective effect remains to be determined (Velasquez MT et al., 2003).

Flaxseed in Bone Health

Alpha linolenic acid, the omega-3 fat found in flaxseed promotes bone health by helping to prevent excessive bone turnover-when consumption of foods rich in these omega-3 fat results in a lower ratio of omega-6 to omega-3 fats in the diet (Griel AE et al., 2007). When the women who had been having 14 hot flashes per week for at least a month and weren't taking estrogen to relieve their menopausal symptoms were fed 2 tablespoons of crushed flaxseed twice daily for six weeks, the women halved their number of daily hot flashes while taking flaxseed. In addition, the intensity of the women's hot flashes dropped by 57%. Side effects included abdominal bloating (14 women) and mild diarrhea (8 women) (Pruthi S et al., 2007).

Journal of Advancement in Pharmacognosy
Volume 4 Issue 1, 2023
ISSN: 2582-8401

Are there any risks to eating flaxseed?

Some people may be allergic to flax seeds, though it is not common (Kang Y et al., 2017). Flax seeds also contain trace amounts of potential toxins like cyanide. But, the consumption of flax is highly unlikely to cause cyanide toxicity because levels are very low and the body can detoxify cyanide in amounts as small as those found in flax seeds. Additionally, cooking flax seeds destroys the chemical (Parikh M et al., 2019).

Tips for Consuming Flax Seeds

When shopping for flax seeds, opt for ground flax seeds over whole ones since whole seeds can pass through your intestines undigested. This prevents nutrients from being absorbed into the bloodstream (National Library of Medicine. Healthy food trends—flaxseeds). If whole flax seeds are your only option, no worries, you can grind them yourself with a coffee grinder just before eating.

Just make sure you store your flax seeds in a cool, dark place—like the freezer—since the oil in flax breaks down when exposed to light and air.

Simple ways to eat flax seeds include: Sprinkled on oatmeal or overnight oats. Mixed into yogurt. Added to pancake batter. Used as a garnish for snacks like smoothies, fresh fruit, and avocado toast. Folded into nut butter along with oats to make energy balls. Baked into cookies, muffins, brownies, and banana bread. You can also use flax seeds as a vegan replacement for eggs in baking recipes. Just mix one tablespoon of ground flax seeds with three tablespoons of water for each egg the recipe calls for.

CONCLUSION

While small, flax seeds pack a nutritious punch thanks to their ability to reduce blood pressure, improve digestion, and prevent certain types of cancer. They're also quite versatile, as they can be incorporated into both sweet, savory, hot, and cold dishes. Whether you should consume flax seeds and how often should be based on your own personal preferences and individual health needs. For tailored advice, talk to your healthcare provider or dietitian for tailored guidance.

There has always been a demand for nutritious and health promoting foods in the global market and more so in the recent times. Flaxseed has considerable potential to be utilized as a whole grain and in food formulations as a dietary source. Flaxseeds are not only rich in polysaccharides and oil contents but are also abundant in ω-3 fatty acids, soluble and insoluble fibers, lignans and phytochemicals, phytoestrogens. In spite of this, until recently, flaxseeds were not very consumer compliant. However, there has now been a revival in its usage as a functional food. Consumers are reverting back to the usage of flaxseed in the diet due to its multifarious advantages. Therefore, the incorporation of flaxseeds in nutraceuticals and in dietary supplements will bestow considerable health benefits on the consumers.

REFERENCES

1) Adlercreutz H, Fotsis T, Heikkinen R, Dwyer JT, Woods M, et al. (1982) Excretion of the lignans enterolactone and enterodiol and of equol in omnivorous and vegetarian postmenopausal women and in women with breast cancer. Lancet 2: 1295-1299.
2) Adlercreutz H, Fotsis T, Lampe J, Wähälä K, Mäkelä T, et al. (1993) Quantitative determination of lignans and isoflavonoids in plasma of omnivorous and vegetarian

Journal of Advancement in Pharmacognosy
Volume 4 Issue 1, 2023
ISSN: 2582-8401

women by isotope dilution gas chromatography-mass spectrometry. Scand J Clin Lab Invest Suppl 215: 5-18.

3) Bailey, L. H.; Bailey, E. Z. 1976. Hortus third: a concise dictionary of plants cultivated in the United States and Canada. Liberty Hyde Bailey Hortorium. New York, USA: Macmillan.
4) Beard, B. H., Comstock, V. E. 1965. Flax genetics and gene symbolism. Crop Sci 5:151-155
5) Block G, Patterson B, Subar A (1992) Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. Nutr Cancer 18: 1-29.
6) CABI (Centre for Agriculture and Biosciences International) Crop Protection Compendium. 2018. *Linum usitatissimum* datasheet. Available: https://www.cabi.org/cpc/datasheet/31053. [2018, Feb 16,].
7) Cloutier S., Ragupathy R., Miranda E., Radovanovic N., Reimer E., Walichnowski A., Ward K., Rowland G., Duguid S., Banik M. 2012. Integrated consensus genetic and physical maps of flax (*Linum usitatissimum L.*). Theor Appl Genet125:1783–1795
8) Diederichsen, A. 2007. Ex situ collections of cultivated flax (*Linum usitatissimum* L.) and other species of the genus *Linum L.* Genet Resour Crop Evol 54(3):661–678.
9) Dupasquier CMC, Dibrov E, Kneesh AL, Cheung PKM, Lee KGY, et al. (2007) Dietary flaxseed inhibits atherosclerosis in the LDL receptor-deficient mouse in part through antiproliferative and anti-inflammatory actions. Am J Physiol Heart Circ Physiol 293: H2394-H2402.
10) Fernald, M. L. 1950. Gray's Manual of Botany. Eighth edition (Corrected Printing, R.C. Rollins, 1970). D. Van Nostrand Company, New York, NY. 1632 p.
11) Frische EJ, Hutchins AM, Martini MC, Thomas W, Slavin JL (2003) Effect of flaxseed and wheat bran on serum hormones and lignan excretion in premenopausal women. J Am Coll Nutr 22: 550-554.
12) Fuchs D, Piller R, Linseisen J, Daniel H, Wenzel U (2007) The human peripheral blood mononuclear cell proteome responds to a dietary flaxseed-intervention and proteins identified suggest a protective effect in atherosclerosis. Proteomics 7: 3278-3288.
13) Griel AE, Kris-Etherton PM, Hilpert KF, Zhao G, West SG, et al. (2007) An increase in dietary n-3 fatty acids decreases a marker of bone resorption in humans. Nutr J 6: 2.
14) Health Canada. 2014. Summary of Health Canada's Assessment of a Health Claim about Ground Whole Flaxseed and Blood Cholesterol Lowering. labelling/health claims/assessments/ground-whole-flaxseed-blood-cholesterol-lowering-nutrition-health-claims-food-labelling.html.[Accessed November 19, 2018],
15) Jenkins DJ, Kendall CW, Vidgen E, Agarwal S, Rao AV, et al. (1999) Health aspects of partially defatted flaxseed, including effects on serum lipids, oxidative measures, and ex vivo androgen and progestin activity: a controlled crossover trial. Am J Clin Nutr 69: 395-402.
16) Kang Y, Park SY, Noh S, et al. Case report: A first case of flaxseed-induced anaphylaxis in Korea. *Medicine (Baltimore)*. 2017;96(49):e8220. doi:10.1097/MD.0000000000008220
17) Lucas EA, Wild RD, Hammond LJ, Khalil DA, Juma S, et al. (2002) Flaxseed improves lipid profile without altering biomarkers of bone metabolism in postmenopausal women. J Clin Endocrinol Metab 87: 1527-1532.

Journal of Advancement in Pharmacognosy
Volume 4 Issue 1, 2023
ISSN: 2582-8401

18) Makni M, Fetoui H, Gargouri NK, Garoui EM, Jaber H, et al. (2008) Hypolipidemic and hepatoprotective effects of flax and pumpkin seed mixture rich in ω-3 and ω-6 fatty acids in hypercholesterolemic rats. Food Chem Toxicol 46: 3714-3720.
19) Mandaşescu S, Mocanu V, Dăscaliţa AM, Haliga R, Nestian I, et al. (2005) Flaxseed supplementation in hyperlipidemic patients. Rev Med Chir Soc Med Nat Iasi 109: 502-506.
20) Ogborn MR, Nitschmann E, Bankovic-Calic N, Weiler HA, Aukema HM (2006) Effects of flaxseed derivatives in experimental polycystic kidney disease vary with animal gender. Lipids 41: 1141-1149.
21) Pandey, K. K. 1956. Studies in autotetraploids of linseed (*Linum usitatissimum* L.). I. Growth rate. Lloydia 19: 120-128
22) Parikh M, Maddaford TG, Austria JA, Aliani M, Netticadan T, Pierce GN. Dietary Flaxseed as a Strategy for Improving Human Health. *Nutrients*. 2019;11(5):1171. Published 2019 May 25. doi:10.3390/nu1105117.
23) Parkin DM, Muir CS, Whelan SL, Gao Y, Ferlay J, et al. (1992) Cancer incidence in five continents. IARC Scientific Publication, Lyon, France.
24) Paschos GK, Magkos F, Panagiotakos DB, Votteas V, Zampelas A (2007) Dietary supplementation with flaxseed oil lowers blood pressure in dyslipidaemic patients. Eur J Clin Nutr 61: 1201-1206.
25) PGRC (Plant Gene Resource of Canada). 2018. Entries for Taxa in the GRIN-CA database. http://pgrc3.agr.gc.ca/cgi-bin/npgs/html/tax_search_new.pl. Accessed 25 May 2018.
26) Phipps WR, Martini MC, Lampe JW, Slavin JL, Kurzer MS (1993) Effect of flax seed ingestion on the menstrual cycle. J Clin Endocrinol Metab 77: 1215-1219.
27) Pruthi S, Thompson SL, Novotny PJ, Barton DL, Kottschade LA, et al. (2007) Pilot evaluation of flaxseed for the management of hot flashes. J Soc Integr Oncol 5: 106-112.
28) Przybylski, R. 2001. Flax oil and high linolenic oils. In Bailey's industrial oil and fat products. 6th edition. Edited by Shahidi F. Hoboken: John Wiley & Sons, Inc; 281–301.
29) Qiu Sheng-Xiang, Lu Zhi-Zhen, Luyengi L, Lee SK, Pezzuto JM, et al. (1999) Isolation and Characterization of Flaxseed *(Linum usitatissimum)* Constituents. Pharm Biol 37: 1-7.
30) Ragupathy, R., Rathinavelu, R., Cloutier, S. 2011. Physical mapping and BAC-end sequence analysis provide initial insights into the flax (*Linum usitatissimum* L.) genome. BMC Genomics, 12(1):217.
31) Rickard SE, Orcheson LJ, Fong HH (1996) Antitumorigenic effect of a mammalian lignan precursor from flaxseed. Nutr Cancer 26: 159-165.
32) Ross J. C., and Boyce J. W. 1946. Tetraploidy in flax. Can. J. Res. C. 23: 124-126.
33) Thompson LU, Rickard SE, Cheung F, Kenaschuk EO, Obermeyer WR (1997) Variability in anticancer lignan levels in flaxseed. 19. Serraino M, Thompson LU (1991) The effect of flaxseed supplementation on early risk markers for mammary carcinogenesis. Cancer Lett 60: 135-142.
34) Thompson LU, Seidl MM, Nutr Cancer 27: 26-30.
35) Ueshima H, Stamler J, Elliott P, Chan Q, Brown IJ, et al. (2007) Food omega-3 fatty acid intake of individuals (total, linolenic acid, long-chain) and their blood pressure: INTERMAP study. Hypertension 50: 313-319.
36) US Department of Agriculture. Seeds, flaxseed.
37) van Zeist, W., and Bakker-Heeres, J.A.H. (1975). Evidence for linseed cultivation before 6000 BC. *J. Archaeological Sci.* 2, 215–219.

Journal of Advancement in Pharmacognosy
Volume 4 Issue 1, 2023
ISSN: 2582-8401

38) Velasquez MT, Bhathena SJ, Ranich T, Schwartz AM, Kardon DE, et al. (2003) Dietary flaxseed meal reduces proteinuria and ameliorates nephropathy in an animal model of type II diabetes mellitus. Kidney Int 64: 2100-2107.
39) Westcott N. A., Muir A. D. 2003. Flax seed lignan in disease prevention and health promotion. *Phytochem Rev* 2:401–417.