



Review Article

Flax Seeds (*Linum usitatissimum*): Nutritional composition and health benefitsShekhara Naik R¹, Anurag AP¹, Prakruthi M², Mahesh MS^{1,*}¹Dept. of Food Science and Nutrition Yuavraja's College, Yuvaraja's College, Mysuru, Karnataka, India²Central Food Technological Research Institute, India

ARTICLE INFO

Article history:

Received 02-07-2020

Accepted 08-07-2020

Available online 05-08-2020

Keywords:

Flax seeds

Linseed

Linum usitatissimum

Hypocholesterolemic alpha linoleic acid

ABSTRACT

Flax seeds are one of the potential oil seeds packed with excellent amount of nutrition and possess various health benefits. Interestingly, flax seeds' health benefits are mainly attributed to the omega-3 fatty acids, lignans and fiber they contain. It is used in different forms, such as whole and flour. The flour is used in bakery products and provides nutty flavour, nutritional and health benefits of the final product. Consumption of this oil seed may lower both total and LDL cholesterol because of its low content of saturated fat, high PUFA and phytosterol content. Processing of flax seeds makes its nutrients are bioavailable. In this review, nutrition composition and the health benefits of the flaxseed has been discussed.

© 2020 Published by Innovative Publication. This is an open access article under the CC BY-NC license (<https://creativecommons.org/licenses/by-nc/4.0/>)

1. Introduction

Flaxseed (*Linum usitatissimum*) is also known as linseed and these terms are used interchangeably. 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, Akse bija in Indian languages.² The Latin name of the flaxseed is *Linum usitatissimum*, which means "very useful".³

Flaxseed was first introduced in United States by Colonists, primarily to produce fiber for clothing. Flaxseed was used for the fabrication of cloths and papers, while flaxseed oil and its sub-products are used in animal feed formulation.³

Flaxseeds are obtained from blue flowering annual herb and belong to Linaceae family. Flax plants grow from 12 to 40 inches high.⁴ The plant has a slender and fibrous stem and its bright blue flowers are up to 3 cm in diameter.⁵ The flowers have five petals and form a five-celled ball that can contain up to 10 seeds. Flowering continues until plant growth stops. The spherical fruit capsules contain two seeds

in each of five compartments. Fiber flax varieties are tall, unbranched plants that are grown at very high density to maximize fiber production.⁶



Fig. 1: Flax Seed Plant

The whole flaxseed is flat and oval with pointed tips and contains a seed coat or true hull (also called testa), a thin endosperm, two embryos and an embryo axis. It have smooth glossy surface. It varies in color from dark brown to yellow.⁷ The texture of flaxseed is crisp and chewy possessing a pleasant nutty taste.⁸ Distinct varieties namely Sheela, Sweta, Garima, Sharda, Rashmi, Shikha, Padmini,

* Corresponding author.

E-mail address: mavavishiva@gmail.com (Mahesh MS).



Fig. 2: Light and Dark Brown Coloured Flax Seeds

Shekhar, Neelam, LC-2063 and LC-2023 are cultivated in India have been developed for oilseed and fiber flax.⁹ Oilseed flax varieties tend to be short, highly branched plants bred to maximize the number of flowers per unit area. India ranks first among the leading flaxseed producing countries in terms of acreage accounting 23.8 % of the total and third in production contributing to 10.2 % of the world's production.^{10,11} In India, it is mainly cultivated in Madhya Pradesh, Maharashtra, Chhattisgarh and Bihar. Almost all parts of linseed plant are utilized for various purposes. Seed contains oil which after refining is used for edible purpose.^{10,11} It has been used in various forms such as flour, oil and seed.¹²

Flaxseed and flaxseed oil is considered to have potential health benefits due to presence of various biologically active compounds and elements including linolenic acid, linoleic acid, lignans, cyclic peptides, polysaccharides, alkaloids, cyanogenic glycosides, and cadmium.¹³ It relishes a good status among oilseeds because of its versatile uses. It has emerged as a captivating nutritional food because of its exceptionally high content of alpha-linolenic acid (ALA), dietary fiber, high quality protein and phytoestrogens.

In the last two decades, flaxseed has been the grabbing the attention of the nutritionists and researchers in the field of diet and disease research due to the potential health benefits associated with some of its biologically active components.—ALA, lignan-Secoisolariciresinol diglycoside (SDG) and dietary fiber.¹⁴ The roots of *L. usitatissimum* contain measurable concentrations of lignans and isoflavones.⁴ The growing popularity of flax is due to its potentiality in reducing - cardiovascular diseases, risk of cancer, particularly of the mammary and prostate gland cancer, anti-inflammatory activity, laxative effect, and alleviation of menopausal symptoms and osteoporosis.¹⁵ Flaxseed has new prospects as functional food at present because of consumer's growing interest for food with superb health benefits. It has become an attractive ingredient in the diets specially structured for specific health benefits because of its excellent nutritional profile and promising health benefits.¹⁶

Flaxseed is well-known for the content of chemical compounds with specific biological activity and functional properties like solubility, thermal stability, emulsifying properties and electrostatic charge density, water holding and fat absorption capacities polyunsaturated fatty acids (PUFA) omega-3 family, soluble dietary fibers, lignin's, proteins and carbohydrates.¹⁶ An analysis of flax averaged 41% fat, 20% protein, 28% total dietary fibre, 7.7% moisture and 3.4% ash, which is the mineral-rich residue left after samples are burned. The protein content of the seed decreases as the oil content increases.¹⁷ Brown and yellow varieties of flaxseed are virtually identical in their nutrient content.¹⁸ The amount of pigment present determines the seed coat colour, a feature that can be changed through normal plant breeding practices.

Nutritionists all over the world suggest incorporation of omega 3 fatty acid sources in the diet. Flaxseed serves as the best omega 3 fatty acid source to the non-fish eaters. Edible flaxseed products include the whole flaxseed, ground meal and extracted oil or mucilage. These products have been intended to use as nutritional additives in the preparation of a number of dietary items such as baked cereal products, ready to eat cereals, fiber bars, salad toppings, meat extenders, bread, muffins and spaghetti.^{10,11}

1.1. Nutrient composition

The protein content in flaxseed has been reported to between 10.5% and 31%.¹² Khategaon cultivars grown in India had a protein content of 21.9%.¹⁹ Differences in protein can be attributed to both genetics and environment. The proximate protein content of dehulled and defatted flaxseed varied considerably depending upon cultivar growth location and seed processing. However, the dehulled and defatted meals have high protein content.²⁰ The major proteins in flax is albumin and globulin. Globulin fraction makes up to 73.4% and the albumin constitutes about 26.6% of total protein.

Flaxseed proteins are relatively high in arginine, aspartic acid and glutamic acid, while lysine is limiting.^{10,11,21} High cysteine and methionine contents improve the antioxidant levels, thus helps in reducing risk of cancer.¹² Total amino acid content of the flaxseed after 8 days of germination increased by 15 times with greatest increase (i.e. 200 times) being observed in glutamine and leucine compared to the original seed The total nitrogen content is 3.25 g/100 g of seed.²² Flaxseed proteins exhibit antifungal properties against *Alternaria solani*, *Candida albicans* and *Aspergillus flavus*.^{23,24}

Flaxseed is the richest plant source of ω -3 fatty acid i.e. α -linolenic acid (ALA), low in saturated fatty acids (9%), moderate in monounsaturated fatty acids (18%), and rich in polyunsaturated fatty acid (73%). Moreover it is considered to be a source of α -Linolenic Acid (ALA), ALA has greater bioavailability in oil than in milled seed, and has greater bioavailability in oil and milled seed than in whole seed.²⁵

Omega-3 and omega-6 fatty acids are the two groups of omega fats. There are three types of omega-3 fatty acids which are of nutrition importance namely, Linolenic acid, eicosapentaenoic acid (EPA) and docosahexanoic acid (DHA). All three fatty acids have been shown to reduce the risk of cardiovascular disease.² Flax contains a mixture of fatty acids. It is rich in polyunsaturated fatty acids, particularly α -Linolenic Acid, the essential omega-3 fatty acid, and linoleic acid (LA), the essential omega-6 fatty acid. These two polyunsaturated fatty acids are essential for humans – that is, the body needs them. ALA and Linoleic acid constitutes 57% and 16.0 % of total fatty acids respectively in flax making the richest source of ALA. ALA, being the essential fatty acid, requirement can be fulfilled by intake of flaxseed products.¹⁸

It also constitutes about 28% of dietary fiber. Diets rich in dietary fibre may help reduce the risk of heart disease, diabetes, colorectal cancer, obesity and inflammation.¹⁸ The proportion of soluble to insoluble fiber varies between 20:80 and 40:60.³ However, flax is low in carbohydrates (sugars and starches), providing only 1 g / 100 g. For the reason that flax contributes little to total carbohydrate intake, it's recommended for the individual with specific diseases. Flaxseed polysaccharide is composed of two major fractions: a neutral arabinoxylan (75%) and an acidic rhamnolacturonan (25%).²⁶ It serves as a good source of minerals especially, phosphorous (650 mg/100 g), magnesium (350–431 mg/100 g), calcium (236–250 mg/100 g) and has very low amount of sodium (27 mg/100g).¹ It contains highest amount of potassium 5600–9200 mg/kg among various foods and high potassium intake is inversely related to blood platelet aggregation, free radicals in blood and stroke incidence.⁸

Flaxseed contains small amounts of water-soluble and fat-soluble vitamins. Vitamin E is present as γ -tocopherol, amounting to 39.5 mg/100 g. γ -tocopherol is an antioxidant providing protection to cell proteins and fat from oxidation; promotes sodium excretion in urine, which may help in lowering of blood pressure and heart disease risks and Alzheimer disease.¹ Besides it contain a good amount of phenolic compounds. These phenolic compounds are well known for anticancer and anti-oxidative properties. Basically, flaxseeds have three different types of phenolic compounds—phenolic acids, flavonoids and lignans. Major phenolic acids present in defatted flaxseed are ferulic acid (10.9 mg/g), chlorogenic acid (7.5 mg/g), gallic acid (2.8 mg/g). Other phenolic acids include p-coumaric acid glucosides, hydroxycinnamic acid glucosides and 4-hydroxybenzoic acid that are present in low quantities.^{27,28} Flavone C- and Flavone O-glycosides are the major flavonoids found in flaxseeds.²⁷ Flaxseed is the richest source of phytoestrogens (lignans). The amount of secoisolariciresinol diglycoside (SDG) varies from 77 to 209 mg SDG/tbsp. of whole flaxseed.^{1,14} Flaxseed contains

very low level of carbohydrates (1 g/100 g) and thus contributing very little to total carbohydrates intake.¹

1.2. Health benefits

Flaxseed has been grown since the beginnings of civilization, and in the world arena, people have celebrated its usefulness throughout the ages. 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.,²⁹ 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.²⁶ 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.³

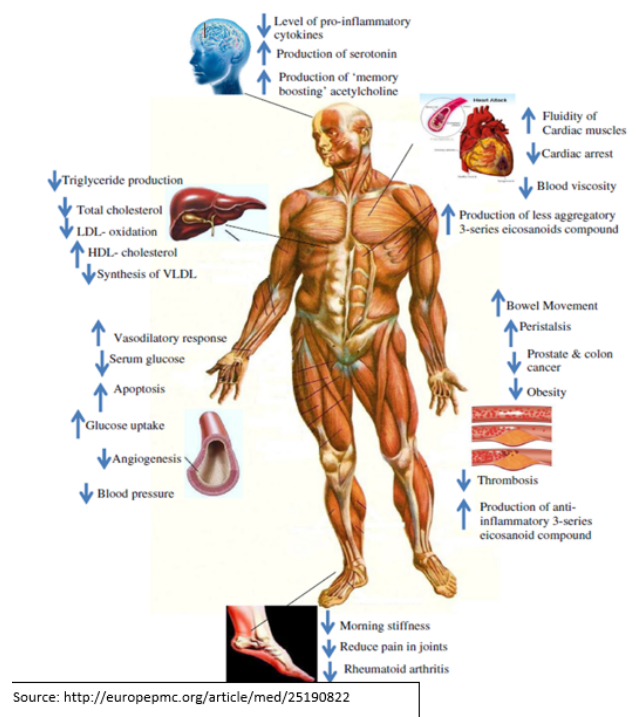


Fig. 3: Physiological Effects of Functional Elements in Flax Seeds

Flaxseed possesses antioxidant and hepatoprotective properties. Several studies advocated the cholesterol

Table 1: Nutritional composition of flax seed

Form of Flax	Carbohydrate (g)	Protein (g)	Total fat (g)	α -Linolenic Acid (g)	Total Dietary fibre (g)	Energy (Kcal)
Whole seed	28.8	20.0	41.1	22.7	27.7	450
Ground seed	29.2	20.0	40.7	23.0	27.6	450
Flax oil	-	-	100.0	57	-	884

Source: (Morris, 2003)

Table 2: Fatty acids content of Flaxseed oil

Parameter	Percentage (%)
Saturated fat	9.0
Monounsaturated fat	18.0
Linoleic acid (omega-6 fatty acid)	16.0
α -Linolenic acid (omega-3 fatty acid)	57.0

Source: (Morris, 2003)

lowering benefits of flaxseed meal.^{30–32} 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.³³ 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.^{34–36}

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.^{37,38} 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.^{39,40}

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.^{41,42}

In postmenopausal women, lignans act as weak estrogens, while at normal estrogen levels, lignans act as estrogen antagonists.^{43,44} Dietary flaxseed moderately lowers the serum levels of steroid sex hormones which are implicated in development of breast cancer in obese postmenopausal women.⁴¹

Traditionally, dietary fiber is used for the treatment of constipation, irritable bowel syndrome.^{45,46} Dietary fiber delays gastric emptying, regulate post prandial blood glucose levels and helpful in prevention of constipation.⁴⁷ 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.^{48,49} Soluble gum of the flaxseed may be helpful in the prevention of cardiovascular diseases by exhibiting hypocholesterolemic effect.^{50,51} It was observed that flax fiber enriched drink lowered the cholesterol to a large extent as compared to fiber enriched bread.⁵² 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.⁵³

2. Conclusion

Flaxseed encompasses the potential health suiting nutritional profile in it. However, many people are still unaware of the potential health benefits of flaxseed and food applications. 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. Its long journey from being a medicine in ancient times to the health food source in 21st century has opened the doors for a large population. 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. General recommendation for daily intake has been 1–3 table spoons per day for ground flaxseed or 1 table spoon for flaxseed oil. Recently baking and pasta companies have incorporated flaxseed into their formulations. There is no doubt that a change to an omega-3 rich and high fiber diet would be beneficial. Therefore the use of flaxseed in whole seed or ground form can be recommended as a dietary supplement.

3. Source of Funding

None.

4. Conflict of Interest

None.

References

- Morris DH. Flax—a health and nutrition primer; 2007.
- Ganorkar P. Flaxseed - a nutritional punch. *Int Food Res J*. 2013;1.
- Goyal A. Flax and flaxseed oil: an ancient medicine & modern functional food. *Assoc Food Sci Technologists*. 2014;1.
- Halligudi N. Pharmacological properties of Flax seeds:A Review. *Hygeia: J Drugs Med*. 2012;2(3).
- Rubilar M. Flaxseed as a source of functional ingredients. *Soil Sci Plant Nutr*. 2010;1(2).
- Vaisey-Genser M. History of the cultivation and uses of flaxseed. London: Taylor and Francis; 2003. p. 1–21.
- Freeman T. Structure of flaxseed. Champaign Illinois: AOCS Press; 1995. p. 11–21.
- Carter J. Potential of flaxseed and flaxseed oil in baked goods and other products in human nutrition. *Cereal Food World*. 1993;p. 3–5.
- Singh KK. Selected Engineering and Biochemical Properties of 11 Flaxseed Varieties. *Food Bioprocess Technol*. 2001;1.
- Singh KK, Jhamb SA, Kumar R. 2011.
- Singh KK, Mridula D, Rehal J, Barnwal P. Flaxseed: A Potential Source of Food, Feed and Fiber. *Criti Rev Food Sci Nutr*. 2011;51(3):210–22.
- Oomah BD. Flaxseed as a functional food source. Nutritional Enhancement of Plant Foods; 2001. p. 4–5.
- Shima Y. Flaxseed (*Linum usitatissimum* L.) bioactive compounds and peptide nomenclature:A review. Trends in Food Science & Technology. 2002;2.
- Toure A, Xueming X. Flaxseed lignans: source, biosynthesis, metabolism, antioxidant activity, bio-active components and health benefits. *Compr Rev Food Sci Food Saf*. 2010;9:261–9.
- Neil DW. Flax seed lignan in disease prevention and health promotion. Kluwer Academic Publishers; 2004.
- Kaushik K. Preparation, characterization and functional properties of flax seed protein isolate. Elsevier; 2015. p. 4–6.
- Malcolmsona L. Storage Stability of Milled Flaxseed. *J Am Oil Chemists' Soc*. 2000;p. 3–5.
- Morris D. Flax, a health and nutrition primer. Flax Council of Canada; 2003. p. 2–5.
- Madusudhan K. Studies on linseed proteins. Agricultural and Food Chemistry; 1983. p. 959–63.
- Oomah BD, Mazza G. Effect of dehulling on chemical composition and physical properties of flaxseed. *Lebensm Wiss Technol*. 1997;30:135–40.
- Chung MWY, Lei B, Li-Chan ECY. Isolation and structural characterization of the major protein fraction from NorMan flaxseed (*Linum usitatissimum* L.). *Food Chem*. 2005;90(1-2):271–9.
- Gopalan C, Sastri R, Balasubramanian SC. Nutritive value of Indian foods. Hyderabad: National Institute of Nutrition, ICMR; 2004.
- Xu Y, Hall C, Wolf-Hall C. Antifungal Activity Stability of Flaxseed Protein Extract Using Response Surface Methodology. *J Food Sci*. 2007;73(1):M9–M14.
- Xu Y, Hall C, Wolf-Hall C. Antifungal Activity Stability of Flaxseed Protein Extract Using Response Surface Methodology. *Food Microbiol Saf*. 2007;73(1):M9–M14.
- Pellizzon M. Flaxseed reduces plasma cholesterol levels in hypercholesterolemic mouse models. *J Am Coll Nutr*. 2007;.
- Bernacchia P. Chemical Composition and Health Benefits of Flaxseed. *Nutr Food Sci*. 2014;p. 2–8.
- Mazza G. Production, Processing and Uses of Canadian Flax. *First CGNA International Workshop*. 2006;.
- Beejmohun V, Fliniaux O, Éric Grand, Lamblin F, Bensaddek L, Christen P, et al. Microwave-assisted extraction of the main phenolic compounds in flaxseed. *Phytochem Anal*. 2007;18(4):275–82.
- Mishra S. Flaxseed- Bioactive compounds and health significance. *Humanit Soc Sci (IOSR-JHSS)*. 2013;p. 3–4.
- Cunnane SC. High linolenic acid flaxseed (*Linum usitatissimum*): some nutritional properties in humans. *Br J Nutr*. 1993;69:443–53.
- Ridges L, Sunderland R, Moerman K, Meyer B, Astheimer L, Howe P, et al. Cholesterol lowering benefits of soy and linseed enriched foods. *Asia Pacific J Clin Nutr*. 2001;10(3):204–11.
- Bhathena SJ, Ali AA, Haudenschild C, Latham P, Ranich T, Mohamed AI, et al. Dietary Flaxseed Meal is More Protective Than Soy Protein Concentrate Against Hypertriglyceridemia and Steatosis of the Liver in an Animal Model of Obesity. *J Am Coll Nutr*. 2003;22(2):157–64.
- Shakir K, Madhusudan B. Hypocholesterolemic and hepatoprotective effects of flaxseed chutney: evidence from animal studies. *Int J Clin Biochem*. 2007;22:117–121.
- Maes M, Smith R, Christophe A, Cosyns P, Desnyder R, Meltzer H, et al. Fatty acid composition in major depression: decreased ω 3 fractions in cholesteryl esters and increased C20:4 ω 6C20:5 ω 3 ratio in cholesteryl esters and phospholipids. *J Affect Disord*. 1996;38(1):35–46.
- Tiemeier H, van Tuijl HR, Hofman A, Kiliaan AJ, Breteler MM, et al. Plasma fatty acid composition and depression are associated in the elderly: the Rotterdam Study. *Am J Clin Nutr*. 2003;78(1):40–6.
- Locke CA, Stoll AL. Omega-3 fatty acid in major depression. *World Rev Nutr Diet*. 2001;89:173–85.
- Schweigerer L, Christeleit K, Fleischmann G, Adlercreutz H, Wahala K, Hase T, et al. Identification in human urine of a natural growth inhibitor for cells derived from solid paediatric tumours. *Eur J Clin Invest*. 1992;22(4):260–4.
- Prasad K. Hydroxyl radical-scavenging property of secoisolariciresinol diglucoside (SDG) isolated from flax-seed. *Mol Cell Biochem*. 1997;168:117–23.
- Adlercreutz H. Western diet and western diseases: some hormonal and biochemical mechanisms and associations. *Scand J Clin Lab Investig Suppl*. 1990;201:3–23.
- Morton MS, Chan PSF, Cheng C, Blacklock N, Matos-Ferreira A, Abranches-Monteiro L, et al. Lignans and isoflavonoids in plasma and prostatic fluid in men: Samples from Portugal, Hong Kong, and the United Kingdom. *Prostate*. 1997;32(2):122–8.
- Sturgeon SR, Heersink JL, Volpeb SL, Bertone-Johnson ER, Puleoa E, Stanczyk FZ, et al. Effect of dietary flaxseed on serum levels of estrogens and androgens in postmenopausal women. *Nutr Cancer*. 2008;60:612–8.
- Adlercreutz H, Bannwart C, Wähälä K, Mäkelä T, Brunow G, Hase T, et al. Inhibition of human aromatase by mammalian lignans and isoflavonoid phytoestrogens. *J Steroid Biochem Mol Biol*. 1993;44(2):147–53.
- Wang C, Mäkelä T, Hase T, Adlercreutz H, Kurzer MS. Lignans and flavonoids inhibit aromatase enzyme in human preadipocytes. *J Steroid Biochem Mol Biol*. 1994;50(3-4):205–12.
- Hutchins AM, Slavin JL. Effects of flaxseed on sex hormone metabolism. In: LU T, SC C, editors. Flaxseed in human nutrition. 2. AOCS Press; 2003. p. 126–149.
- Cann PA, Read NW, Holdsworth CD. What is the benefit of coarse wheat bran in patients with irritable bowel syndrome? *Gut*. 1984;25(2):168–73.
- Tarpila A, Wennberg T, Tarpila S. Flaxseed as a functional food. *Curr Top Nutraceutical Res*. 2005;3:167–88.
- Spiller RC. Pharmacology of dietary fibre. *Pharmacol Ther*. 1994;62(3):407–27.
- Thakur G, Mitra A, Pal K, Rousseau D. Effect of flaxseed gum on reduction of blood glucose and cholesterol in type 2 diabetic patients. *Int J Food Sci Technol*. 2009;60(sup6):126–36.
- Kapoor S, Sachdeva R, Kochhar A. Flaxseed: a potential treatment of lowering blood glucose and lipid profile among diabetic females. *Ind J Nutr Diet*. 2011;48:529–36.
- Jenkins D, Wolever T, Kalmusky J. Low glycemic index diet in hyperlipidemia: use of traditional starchy foods. *Am J Clin Nutr*. 1987;46:66–71.
- Cunnane SC, Hamadeh MJ, Liede AC, Thompson LU, Wolever TM, Jenkins DJ, et al. Nutritional attributes of traditional flaxseed in healthy young adults. *Am J Clin Nutr*. 1995;61(1):62–8.

52. Kristensen M, Jensen MG, Aarestrup J, Petersen KE, Søndergaard L, Mikkelsen MS, et al. Flaxseed dietary fibers lower cholesterol and increase fecal fat excretion, but magnitude of effect depend on food type. *Nutr Metab.* 2012;9(1):8.
53. Du H. Dietary fiber and subsequent changes in body weight and waist circumference in European men and women. *Am J Clin Nutr.* 2010;91:329–36.

Anurag AP Student

Prakruthi M Project Assistant

Mahesh MS Assistant Professor

Author biography

Shekhara Naik R Head

Cite this article: Naik R S, Anurag AP , PM, Mahesh MS . **Flax Seeds** (*Linum usitatissimum*): **Nutritional composition and health benefits.** *IP J Nutr Metab Health Sci* 2020;3(2):35-40.