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Flaxseed- A Shield against Diseases?

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Abstract

Modernisation has made our lives comfortable but with an added baggage of problems. One of them is poor health which is because of increased incidences of modern day diseases like obesity, metabolic syndrome, diabetes, cardiovascular diseases, polycystic ovarian disease, allergies of different sorts and some type of cancers. Dietary modification by addition of a functional food, as one of the lifestyle modifications can help us to win our battle against this assortment of diseases. Flaxseed is being labelled as one of the functional foods. This review looks into the different research works and data to see if flaxseed fulfils the criteria of a functional food and can be used as a shield to protect us against these modern day diseases. We came to the conclusion that flaxseed is one of the richest sources of α-linolenic acid and lignan, in addition to being a good dietary source of fibre. Thus, flaxseed a natural source because of the presence of these bioactive compounds can help us in prevention and provide us protection against plethora of diseases. It is recommended that flaxseed a great functional food should be added as a dietary supplement in different forms and worldwide people should be educated about its health benefits.

Keywords: Flaxseed; Functional Food; α-Linolenic Acid (Ala); Lignans; Omega-6 Fatty Acids; Fibre

Abbreviations: SDG: Secoisolariciresinol Di-Glucoside; PUFA: Poly-Unsaturated Fatty Acids; DHA: Decosa-Hexanoic Acid; EPA: Eicosa-Pentaenoic Acid

Introduction

We have progressed in the modern world making our lives comfortable with the help of industrialisation, urbanisation, and globalisation, social and economic developments. These plethoras of events have led to rapid alterations in diets and lifestyles like inappropriate diet, poor quality of nutrition, lack of physical activity and much other behaviour known to be detrimental to health. Thus, large population of people have poor health because of the increased incidences of diseases like obesity, metabolic syndrome, diabetes, cardiovascular diseases, polycystic ovarian disease, allergies of different sorts and some types of cancers. Living a healthy life is a challenge for all of us in the modern day world as we are always being threatened by several degenerate lifestyle diseases. Indigenous populations tradionally used natural products to treat a broad range of diseases and ailments [1,2].

In recent times, many drug discovery experiments have natural products as their main component and because of their chemical diversity have led the researchers to study plant materials in hope of finding their medicinal properties [3,4]. Our quest for wellness and increasing awareness regarding the role of proper diet has made us search for foods that can work like medicine. The answer to this query is 'Functional foods' or 'neutriceuticals' which are basically foods or dietary compounds which not only provide basic nutrition but may also provide a health benefit .i.e., they give a health punch in addition to their traditional nutrient content [5]. Flaxseed is being labelled as a functional food because of its nutritional composition which has positive effects on disease prevention providing health beneficial components [6].

Discussion

Flaxseed is the seed from the flax plant, Latin name being *Linum usitatissmum* which means very useful [7] and is called as flaxseed/linseed, depending on whether it is being used for human consumption or for industrial uses respectively [8,9].

Canada is the major exporter of flaxseed and flaxseed products, approximately 80% of the global trade [8]. An analysis of brown Canadian flax averaged 41% fat, 20% protein, 28% total dietary fibre, 7.7% moisture and 4% Ash which is the mineral residue left after samples are burned [10,11]. Of all the lipids in flaxseed 53% are α-linolenic acid (ALA), 17% linoleic acid (LA), 19% oleic acid, 3% steric acid and 5% palmitic acid and provides an excellent n-6:n-3 fatty acid ratio of approximately 0.3:1[12]. The three components of flaxseed which are generally associated with improved cardiovascular health are [13]:

a. The omega-3 polyunsaturated α-linolenic acid (ALA, 20% of dry weight),

b. The plant lignan: secoisolariciresinol diglucoside (SDG, 1% of dry weight),

c. Soluble fibre (6% of dry weight).

Researchers are trying to find if omega-3 fatty acid: ALA present in flaxseed, which is one of its richest source [14] may help in protecting against certain infections and in treating diseases like ulcers, migraine headaches, eating disorders, attention deficit/hyperactivity disorders, emphysema, psoriasis, preterm labour, glaucoma, Lyme's disease, lupus and panic attacks [15]. Many studies [16-19] done over a period of time have gathered data from large populations and reported that ALA levels are inversely correlated with primary cardiovascular events. Omega-3 fatty acids because of their biological effects have become useful in managing chronic conditions such as type-2 diabetes, kidney disease, hypertension, rheumatoid arthritis, stroke, Alzheimer disease, alcoholism and certain types of cancers [20]. After ingestion, ALA is metabolically converted into omega-3 fatty acids, eicosapentaenoic acid (EPA) and decosahexanoic acid (DHA) [15] and multiple clinical trials have demonstrated that the long chain polyunsaturated fatty acids (PUFA), EPA and DHA can reduce the risk of cardiac death [21-23]. Fish is one of the sources of ALA but due to limited intake of fish worldwide, plant based PUFA: ALA may be an important alternative source and can be obtained from different types of nuts, seeds and seed oils, mainly flaxseed, walnut, canola oil and soybean oil [15]. Flaxseed is one of the most important oilseed crop because we can almost use plant's every part commercially [8,9].

Dupasquier et al. [24] demonstrated that dietary flaxseed can inhibit atherosclerosis by decreasing the levels of circulating cholesterol and also via its anti-proliferative and anti-inflammatory actions at the cellular level [24]. Increased cardiovascular disease, obesity, diabetes, neurodegenerative declines and cancers are linked with chronic inflammation and oxidative stress [25]. High omega 6/omega 3 ratio in diet has found to promote the pathogenesis of many chronic diseases and increased dietary intake of linoleic acid, an omega-6 fatty acid leads to oxidation of low density lipoproteins (LDL), platelet aggregation and interferes with the incorporation of essential fatty acids (EFA) in cell membrane phospholipids. Omega-3 fatty acids exert strong anti-inflammatory effects by suppressing interleukin 1β, tumour necrosis factor-α and interleukin-6 while omega-6 fatty acids are pro-inflammatory [26,27]. Calguiri et al. [28] in their study on patients of peripheral arterial disease, using 30g of milled flaxseed/day for 6 months reported significant decrease in blood pressure, both systolic as well as diastolic and suggested that this might have occurred via soluble epoxide hydrolase inhibition by ALA of flaxseed, which altered oxylipin concentration.

Flaxseed also has bioactive compound lignin [29,30], the main lignan precursor being secoisosolariciresinol diglucoside (SDG) [31], after ingestion this plant SDG is converted to mammalian lignans by bacteria in the human colon [32]. SDG first undergoes hydrolysis to plant lignan secoisolariciresinol (SECO) which is further converted to enterolignans: enterodiol (ED) and enterolactone (EL), then these metabolites (phytoesterogens) are absorbed and exert their health benefits [33,34]. Thompson et al. [35] in their study on breast cancer patients found that daily intake of 25g of flaxseed significantly decreased cell proliferation, increased apoptosis and affect cell signalling by reducing c-erbB2(HER2) expression and proposed that may be lignans by competing with oestradiol for binding to oestradiol receptors act as anti-oestrogens. The mammalian lignan enterolactone has shown to decrease endogenous oestrogen synthesis by inhibiting aromatase activity [35,36]. Szewczyk et al. [37] used the compounds from the extracts of roots, leaves and stems of flax on the human breast cancer cell lines MCF7 (estrogen receptor positive) and BT20 (estrogen receptor negative) for their phytoestrogenic properties and suggested the role of plant extract for prevention of hormone sensitive carcinoma as they observed significant inhibition of cell vitality and proliferation in the MCF7 cell line.

In a study by Farzana et al. [38] on patients of polycystic ovarian disease(PCOS), supplementation with flaxseed powder, led to significant decrease in ovarian volume, number of follicles and improvement in frequency of menstrual cycles, reasoning it to be due to flaxseed causing reduction in testosterone, circulating oestrogen, luteinising hormone, insulin levels and increased follicle stimulating hormone contributing to follicular maturation and the anti-inflammatory actions to the reduction in ovarian volume. A diet of crushed 40g of flaxseeds was compared with the hormonal therapy for alleviating the menopausal symptoms; it was found to have the same effects but also decreased the glucose and insulin levels [39].

A variety of *in-vitro* and *in-vivo* studies have reported that the flaxseed lignan and its mammalian metabolites induce protective effects on many chronic diet related disease through variable mechanisms including phytoestrogenic and antioxidant effects [40-42]. Another study concluded that flaxseed plant lignans SDG and SECO are effective against oxidative stress as they exert strong antioxidant effects [33]. The fibre content of

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flaxseeds is twice that of high fibre beans and varies between 22% to 26% in the form of soluble (mainly mucilage gums) and insoluble (cellulose and lignins) dietary fibres in proportion varying between 20:80 and 40:60 [33,43,44]. It was found that flaxseed dietary fibres have a role in regulating the body weight by suppressing hunger and nutrient absorption, as the gel formed by them when mixed with water delays gastric emptying and decreases blood glucose level [34,45]. It also lowers cholesterol, as the gel surrounds it and doesn't let it to be absorbed and favours its faecal excretion34. Thakur et al. [46] advised the use of flaxseed mucilage in combination with other mucilage providing added benefits for controlling Type 2 Diabetes Mellitus because when they used flaxseed mucilage to reduce the clinical symptoms of diabetes mellitus associated with lipidaemia there was decrease in fasting blood sugar, total cholesterol and LDL. In their study Kristensen et al. [45] found that both flax drink and flax bread reduced plasma total cholesterol, LDL, and increased fat excretion, so they opinioned that viscous flaxseed dietary fibres may be useful for lowering blood cholesterol and potentially play a role in energy balance.

When 55 hypercholesterolemic subjects were given 300/60mg/d of dietary SDG from flaxseed extract for 8 weeks, it significantly decreased total cholesterol, LDL-cholesterol and glucose concentrations in a dose dependent manner [47]. Flaxseed supplementation in postmenopausal women reduced serum total cholesterol, LDL cholesterol, triglycerides, apolipoproteinA-1 and apolipoprotein B concentrations the known risk factors of coronary heart disease [48]. Ingestion of flaxseed in hypertensive individuals produced significant reduction in blood pressure: both systolic and diastolic, with circulating α-linolenic acid levels correlating with systolic and diastolic blood pressures and lignan levels with changes in diastolic blood pressure [49]. Cassani et al. [50] found improvement in the blood levels of total cholesterol, LDL, uric acid, and adiponectin associated with weight loss, decreased systolic blood pressure and also reduction in inflammatory markers: C-reactive proteins (CRP) and tumour necrosis factor-□□□□F-□) □and were in favour of adding flaxseed to a weight loss diet as an important tool to reduce the inflammatory markers CRP and TNF-α. Flaxseed intake decreased fasting glucose with increased insulin sensitivity in overweight or obese individuals with pre-diabetes but with no significant effect on fructosamine, CRP, adiponectin and Interleukin-6(IL-6) [51].

Flax is low in carbohydrates (sugars and starches) so can be advised to persons' with specific diseases as it provides only 1g/100g contributing very little to total carbohydrate intake [34]. If we compare the amino acid pattern of flax protein with that of soybean which is considered as one of the most nutritious of the plant protein it is the same [52] and is rich in essential amino acids that are required for protein synthesis that have their role in maintenance and repair of cells, tissues and organs [34]. Calmodulin is a co-factor involved in the production of nitric oxide responsible for several neurodegenerative diseases and flaxseed protein hydrolysate induces a change in calmodulin's secondary and tertiary structures [53]. It also inhibits angiotensin converting enzyme thus reducing angiotensin a vasoconstrictor which causes an increase in blood pressure [54]. Protein in flaxseed meal was observed to be more effective in reducing proteinuria and renal histologic abnormalities than soyprotein [55].

It has been found that 30g portion of the flaxseed constitutes 7% to 30% of the Recommended Dietary Allowances (RDA) for calcium, magnesium and phosphorous [11]. When its potassium content is compared with the recommended sources such as banana, its high [56] and high potassium intake has seen to be inversely associated with stroke incidences, platelet aggregation [57].

Conclusion and Recommendation

Modernisation along with making our lives comfortable has pushed us into a web of modern diseases like obesity, metabolic syndrome, diabetes, cardiovascular diseases, polycystic ovarian disease, allergies of different sorts and some type of cancers. Recent scientific research works have suggested that adding a functional food as a dietary modification can be one of the lifestyle modifications and play an important role in preventing and protecting us against these chronic diseases. Insight into multiple *in-vitro* and *in-vivo* research studies and data on flaxseed give us strong indication that flaxseed is one of the richest source of α-linoleinic acid and lignan in addition to being rich in dietary fibre. Flaxseed as one of the functional foods can act as protective shield to combat this variety of diseases. It being a good source of ALA can easily replace the fish and other marine sources of ALA whose use is limited worldwide. People should be educated about the health benefits of flaxseed and encouraged to incorporate it in their diet as a supplement in different forms.

'Leave medicines in the chemist's pot if you can cure your patients with food'

(Hippocrates)

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References

1. Balunas MJ, Kinghorn AD (2005) Drug Discovery from Medicinal Plants. Life Sci 78: 431-441.
2. Harvey L (1999) Medicines from Nature: Are natural products still relevant to drug discovery? Viewpoint TIPS 20(5): 196-198.
3. Mishra BB, Tiwari VK (2011) Natural products: An evolving role in future drug discovery. Eur J Med Chem 46(10): 4769-807.
4. Newman DJ, Cragg GM (2010) Natural Products As Sources of New Drugs over the 30 Years from 1981 to 2010. J Nat Prod 75: 311-335.

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5. Katan MB, Roos NMD (2004) Promises and Problems of Functional Foods. Critical Rev Food Sci Nutr 44(5): 369-377.

6. Bozan B, Temelli F (2008) Chemical composition and oxidative stability of flax, safflower and poppy seed and seed oils. Bioresour Technol 99(14): 6354-6359.

7. Daun JK, Barthet VJ, Chornick TL, Duguid S (2003) Structure, composition, and variety development of flaxseed. 2nd AOCS Press, Champaign, IL, USA, p. 1-40.

8. Oomah BD, Mazza G (1999) Health benefits of phytochemicals from selected Canadian crops. Trends in Food Sci Technol 10(6-7): 193-198.

9. Oomah BD (2001) Flaxseed as a functional food source. J Sci Food Agricul 81(9): 889-894.

10. Morris DH (2007) Flax Primer, A Health and Nutrition Primer. Flax Council of Canada 9-19.

11. Singh KK, Mridula D, Rehal J, Barnwal P (2011) Flaxseed: a potential source of food, feed and fibre. Crit Rev Food Sci Nutr 51(3): 210-222.

12. Simopoulos AP (2002) The importance of the ratio of omega-6/omega-3 essential fatty acids. Biomed Pharmacother 56(8): 365-379.

13. Adolphe JL, Whiting SJ, Juurlink BHJ, Thorpe LU, Alcorn J (2010) Health effects with consumption of the flax lignan secoisolariciresinol diglucoside. Br J Nutr 103(7): 929-938.

14. Gebauer SK, Psota TL, Harris WS, Kris-Etherton PM (2006) n-3 fatty acid dietary recommendations and food sources to achieve essentiality and cardiovascular benefits. Am J Clin Nutr 83(6S): 1526S-35S.

15. Harper CR, Edwards MJ, DeFilippis AP, Jacobson TA (2006) Flaxseed oil increases the plasma concentrations of cardio protective (n-3) fatty acids in humans. J Nutr 136(1): 83-87.

16. Hu FB, Stampfer MJ, Manson JE, Rimm EB, Wolk A, et al. (1999) Dietary intake of α-linolenic acid and risk of fatal ischemic heart disease among women. Am J Clin Nutr 69(5): 890-897.

17. Erkkilä AT, Lehto S, Pyorala K, Uusitupa MI (2003) n-3 Fatty acids and 5-y risks of death and cardiovascular disease events in patients with coronary artery disease. Am J Clin Nutr 78(1): 65- 71.

18. Albert CM, Oh K, Whang W, Manson J E, Chae CU, et al. (2005) Dietary alpha-linolenic acid intake and risk of sudden cardiac death and coronary heart disease. Circulation 112(21): 3232-3238.

19. Djousse L, Arnett DK, Carr JJ, Eckfeldt JH, Hopkins PN, et al. (2005) Dietary linolenic acid is inversely associated with calcified atherosclerotic plaque in the coronary arteries. The NHLBI Family Heart Study. Circulation 111(22): 2921-2926.

20. Das UN (2006) Essential Fatty acids - a review. Curr Pharm Biotechnol 7(6): 467-482.

21. Burr ML, Fehily AM, Gilbert JF, Rogers S, Holliday RM, et al. (1989) Effects of changes in fat, fish, and fibre intakes on death and myocardial reinfarction: diet and reinfarction trial (DART). Lancet 2(8666): 757-761.

22. Singh RB, Niaz MA, Sharma JP, Kumar R, Rastogi V, et al. (1997) Randomized, double-blind, placebo-controlled trial of fish oil and mustard oil in patients with suspected acute myocardial infarction: the Indian experiment of infarct survival-4. Cardiovasc Drugs Ther 11(3): 485-491.

23. De Lorgeril M, Salen P, Martin JL, Monjaud I, Delaye J, et al. (1999) Mediterranean diet, traditional risk factors, and the rate of cardiovascular complications after myocardial infarction: final report of the Lyon Diet Heart Study. Circulation 99(6): 779-785.

24. 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(4): H2394-2402.

25. Valko, M, Leibfritz D, Moncol J, Cronin MTD, Mazur M, et al. (2007) Free radicals and antioxidants in normal physiological functions and human disease Int J Biochem Cell Biol 39(1): 44-84.

26. Zhao G , Etherton TD, Martin KR, Gillies PJ, West SG, Kris- Etherton PM (2007) Dietary -linolenic acid inhibits proinflammatory cytokine production by peripheral blood mononuclear cells in hypercholesterolemic subjects. Am J Clin Nutr 85: 385-391.

27. Simopoulos AP (2008) The omega-6/omega-3 fatty acid ratio, genetic variation, and cardiovascular disease. Asia Pac J Clin Nutr 17 (S1): 131-134.

28. Caligiuri SPB, Aukema HM, Ravandi A, Guzman R, Dibrov E, et al. (2014) Flaxseed Consumption Reduces Blood Pressure in Patients With Hypertension by altering Circulating Oxylipins via an α-Linolenic Acid-Induced Inhibition of Soluble Epoxide Hydrolase. Hypertension 64(1): 53-59.

29. Basavaraj M (2009) Potential Benefits of Flaxseed in Health and Disease - A Perspective. Agriculturae Conspectus Scientificus 74(2): 67-72.

30. Lowcock EC, Cotterchio M, Boucher BA (2013) Consumption of flaxseed, a rich source of lignans, is associated with reduced breast cancer risk. Cancer Causes Control 24(4): 813-816.

31. Adlercreutz H (2007) Lignans and human health. Crit Rev Clin Lab Sci 44(5-6): 483-525.

32. Jenab M, Thompson LU (1996) The influence of flaxseed and lignans on colon carcinogenesis and b-glucuronidase activity. Carcinogenesis 17(6): 1343-48.

33. Hu C, Yuan YV, Kitts DD (2007) Antioxidant activities of theflaxseed lignan secoisolariciresinol diglucoside, its aglycone secoisolariciresinol and the mammalian lignans enterodiol and enterolactone *in vitro*. Food Chem Toxicol 45(11): 2219-2227.

34. Bernacchia R, Preyi R, Vinci G (2004) Chemical composition and Health benefits of Flaxseed. Austin J Nutri Sci 2(8): 1045.

35. Thompson LU, Chen JM, Li T, Stresser-Weippl K, Goss P (2005) Dietary flaxseed alters tumor biological markers in postmenopausal breast cancer. Clin Cancer Res 11(10): 3828-3835.

36. Wang C, Makela T, Hase T, Adlercreutz H, Kurzer MS (1994) Lignans and flavonoids inhibit aromatase enzyme in human preadipocytes. J Steroid Biochem Mol Biol 50: 205-212.

37. Szewczyk M, Abarzua S, Schlichting A, Nebe B, Piechulla B, et al. (2014) Effects of extracts from Linum usitatissimum on cell vitality, proliferation and cytotoxicity in human breast cancer cell lines. J Medicinal Plants Res 8(5): 237-245.

38. Farzana KF, Sulaiman FA, Ruckmani A, Vijayalakshmi K, Lakshmi GK, et al. (2015) Effects of Flax Seeds Supplementation in PolyCystic Ovarian Syndrome. Int J Pharm Sci Rev Res 31(1): 113-119.

39. Lemay A, Dodin S, Kadri N, Jacques H, Forest JC (2002) Flaxseed dietary supplement versus hormone replacement therapy in hypercholesterolemic menopausal women. Obstet Gynecol 100(2): 495-504.

40. Kitts D, Yuan YV, Wijewickreme, AN, Thompson LU (1999) Antioxidant activity of the flaxseed lignan secoisolariciresinol diglycoside and its mammalian lignan metabolites enterodiol and enterolactone. Mol Cell Biochem 202(1-2): 91-100.

41. Prasad K (2000) Antioxidant activity of secoisolariciresinol diglucosidederived metabolites, secoisolariciresinol, enterodiol, and enterolactone. Int J of Angiol 9(4): 220-225

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42. Yuan YV, Rickard SE, Thompson LU (1999) Short-term feeding of flaxseed or its lignan has minor influence on in vivo hepatic antioxidant status in young rats. Nutr Res 19(8): 1233-1243.

43. Picur B, Cebrat M, Zabrocki J, Siemion IZ (2006) Cyclopeptides of Linum usitatissimum. J Pept Sci 12(9): 569-574.

44. Qian KY, Cui SW, Goff HD (2012) Flaxseed gum from flaxseed hulls: Extraction, fractionation, and characterization. Food Hydrocolloids 28: 275-283.

45. Kristensen M, Jensen MG, Aarestrup J, Petersen KE, Søndergaard L, et al. (2012) Flaxseed dietary fibers lower cholesterol and increase fecal fat excretion, but magnitude of effect depend on food type. Nutr Metab 9: 8.

46. Thakur G, Mitra A, Pal K, Rousseau D (2009) Effect of flaxseed gum on reduction of blood glucose & cholesterol in Type 2 diabetic patients. Int J Food Sci Nutri 60(S6): 126-136.

47. Zhang W, Wang X, Liu Y, Tian H, Flickinger B, et al. (2008) Dietary flaxseed lignan extract lowers plasma cholesterol and glucose concentrations in hypercholesterolaemic subjects. Br J Nutr 99(6): 1301-1309.

48. 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(4): 1527-1532.

49. Leyva DR, Weighell W, Edel AL, La Vallee, Dibrov E, et al. (2013) Potent Antihypertensive Action of Dietary Flaxseed in Hypertensive Patients. Hypertension 62(6): 1081-1089.

50. Cassani RS, Fassini PG, Silvah JH, Lima CM, Marchini JS (2015) Impact of weight loss diet associated with flaxseed on inflammatory markers in men with cardiovascular risk factors: a clinical study. Nutri J 14: 5.

51. Hutchins AM, Brown BD, Cunnane SC, Domitrovich SG, Adams ER, et al. (2013) Daily Flaxseed consumption improves glycemia control in obese men and women with pre- diabetes: a randomized study. Nutri Res 33(5): 367-375.

52. Rabetafika HN, Van Remoortel V, Danthine S, Paquot M, Blecker C (2011) Flaxseed proteins: food uses and health benefits. Int J Food Sci Technol 46(2): 221-228.

53. Omoni AO, Aluko RE (2006) Mechanism of the inhibition of calmodulin-dependent neuronal nitric oxide synthase by flaxseedprotein hydrolysates. J Am Oil Chemists Soc 83(4): 335-340.

54. Marambe P, Shand P, Wanasundara P (2008) An in-vitro investigation of selected biological activities of hydrolysed flaxseed (Linum usitatissimum L.) proteins. J Am Oil Chemists Soc 85(12): 1155-1164.

55. 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(6): 2100-2107.

56. Goyal A, Sharma V, Upadhyay N, Gill S, Sihag M (2014) Flax and flaxseed oil: an ancient medicine & modern functional food. J Food Sci Technol 51(9): 1633-1653.

57. Carter JF (1993) Potential of flaxseed and flaxseed oil in baked goods and other products in human nutrition. Cereal Food World 38(10): 753-759.

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