

FLAXSEED: POTENTIAL SOURCE FOR VALUE ADDITION

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Introduction

Flaxseed is one of the oldest crops, having been cultivated since the beginning of civilization. The Latin name of the flaxseed is *Linum usitatissimum*, which means "very useful". Flax was first introduced in United States by colonists, primarily to produce fiber for clothing. Every part of the flaxseed plant is utilized commercially, either directly or after processing. Almost all domestic flaxseed produced is used for extracting linseed oil.

In the last two decades, flaxseed has been the focus of increased interest in the field of diet and disease research due to the potential health benefits associated with some of its biologically active components. Its growing popularity is due to health imparting benefits in reducing cardiovascular diseases, decreased risk of cancer, anti-inflammatory activity, laxative effect, alleviation of menopausal symptoms and osteoporosis.



Figure 1. Flaxseeds (Source: <https://nuttyyogi.com/products/flax-seeds>)

Nutritional Composition of Flaxseed

Flaxseed is the richest plant source of the ω -3 fatty acid i.e. α -linolenic acid (ALA). Flaxseed oil is low in saturated fatty acids (9 %), moderate in monosaturated fatty acids (18 %), and rich in polyunsaturated fatty acid (73 %). Of all lipids in flaxseed oil, α -linolenic acid is the major fatty acid ranging from 39.00 to 60.42 % followed by oleic, linoleic, palmitic and stearic acids, which provides an excellent ω -6: ω -3 fatty acid ratio of approximately 0.3:1 (Pellizzon et al., 2007). Although flaxseed oil is naturally high in antioxidant like tocopherols and beta-carotene, traditional flaxseed oil gets easily oxidized after being extracted and purified. The bioavailability of ALA is dependent on the type of flax ingested (ALA has greater bioavailability in oil than in milled seed, and has greater bioavailability in oil and milled seed than in whole seed) (Austria et al., 2008).

Proteins

The protein content of flaxseed varies from 20 to 30 %, constituting approximately 80 % globulins and 20 % glutelin. Flaxseed has an amino acid profile comparable to that of soybean and contains no gluten. Although flax

protein is not considered to be a complete protein due to the presence of limiting amino acid- lysine. It also contains peptides with bioactivities related to the decrease in risk factors of CVD. Whole flaxseed, flaxseed meals and isolated proteins are rich sources of glutamic acid/glutamine, arginine, branched-chain amino acids (valine and leucine) and aromatic amino acid (tyrosine and phenylalanine). The total nitrogen content in flaxseed is 3.25 g/100 g of seed (Gopalan et al., 2007).

Dietary Fibers

Flax fibers are amongst the oldest fiber crops in the world. The use of flax for the production of linen goes back at least to ancient Egyptian times. Flax fiber is extracted from the skin of the stem of the plant. Total flax plant is approximately 25 % seed and 75 % stem and leaves. The stem or non-seed parts are about 20 % fiber, which can be extracted by chemical or mechanical retting. A flax fiber is a natural and biodegradable composite, which exhibits good mechanical properties and low density. Flax fiber is soft, lustrous and flexible; bundles of fiber have the appearance of blonde hair, hence the description “flaxen”. It is stronger than cotton fiber but less elastic. Flax fiber is also a raw material for the high-quality paper industry for the use of printed banknotes and rolling paper for cigarettes and tea bags (Singh et al., 2011).

Minerals

In relation to composition of minerals, the contents of calcium, magnesium and phosphorus are highlighted being that a 30 g portion of the seed constitutes 7 % to 30 % of the recommended dietary allowances (RDAs) for these minerals. Its potassium content is high and comparable to those of recommended sources such as banana on a dry-matter basis. High K⁺ intake is inversely related to stroke incidence, blood platelet aggregation, oxygen-

scavenging free radicals in blood and vascular smooth muscle proliferation (Kajla et al., 2014).

Health Benefits of Flaxseeds

Flaxseed has potential health benefits besides the nutrition, due to mainly 3 reasons: first, due to its high content of ω -3 α -linolenic acid; Second, being rich in dietary soluble and insoluble fibers; and third, due to its high content of lignans, acting as anti-oxidants and phytoestrogens. ALA can be metabolized in the body into docosahexaenoic acid (DHA) (ω -3) and eicosapentaenoic acid (EPA) (ω -3). The health benefits of all ω -3 fatty acids (ALA, EPA and DHA) have been widely reported for several conditions including cardiovascular disease, hypertension, atherosclerosis, diabetes, cancer, arthritis, osteoporosis, autoimmune and neurological disorders (Simopoulos, 2000). Flaxseed has also been reported to act as anti-arrhythmic, anti-atherogenic, and anti-inflammatory agent in addition to improving vascular function (Dupasquier et al., 2006).

Tumor and Cancer Reducing Effects

Interest in research on the association between flaxseed ingestion and risk of cancer emerged when epidemiologic evidences suggested a beneficial relationship. Research in laboratories has shown that flaxseed inhibits the formation of colon, breast, skin, and lung tumors and also reduces blood vessel cell formation in female rats, all suggesting a protective effect against breast, colon and ovarian cancer (Truan et al., 2012). Higher levels of insulin and insulin-like growth factor 1 (IGF-1) increase cancer risk by stimulating cell proliferation and increasing survival of DNA-damaged cells through antiapoptotic mechanisms. Blood insulin has also been associated with increased risk of pancreatic and colorectal cancers. Various studies suggest

that flaxseed added to the diet may lower circulating levels of insulin and IGF-1 (Woodside et al., 2006; Chen et al., 2011).

Prevention of Kidney Diseases

Chronic kidney disease (CKD) is an important health problem among older adults and can lead to end-stage renal disease with its need for dialysis or transplantation for survival. Due to the anti-inflammatory properties of ω -3 fatty acids, it has been suggested that these nutrients may protect the kidneys from damage in adults. PUFA supplementation was observed as reducing renal inflammation and fibrosis in animal models. Gopinath et al. (2011) showed that increased dietary intake of long-chain ω -3 PUFA was inversely associated with the prevalence of CKD. Cardozo et al. (2010) showed that long-term supplementation of omega-3 fatty acids was associated with a significant reduction in systolic and diastolic blood pressure. Hypertension is a risk factor for CKD; hence, the influence of long-chain n-3 PUFA on blood pressure may be a potential mechanism by which it protects the kidneys. However, a positive association between α -linolenic acid and moderate CKD was observed by Gopinath et al. (2011).

Reduction of Dyslipidemia and Cardiovascular Diseases (CVD)

Serum lipid profile is directly related to the risk factors of cardiovascular diseases. It is the most intensely investigated effect studied in animals and humans after supplementation of flax in diet. Studies with flaxseed and its bioactive components have been performed with postmenopausal women, showing positive effects, including hypocholesterolemic and antidiabetic effects of supplementation. When type 2 diabetic patients were fed defatted flaxseeds for 2 months, patients showed significant reduction of plasma glucose, improvement in plasma lipid profile and significant reduction of lipid peroxidation (Mohamed et al., 2012). Dietary flaxseed may also offer protection

against ischemic heart disease by improving vascular relaxation responses and by inhibiting the incidence of ventricular fibrillation (Jennifer et al., 2010). However, Vedtofte et al., (2011) reported that higher intake of ALA was not significantly associated with decreased risk of ischemic heart disease among women or men.

Natural Treatment of Bowel Syndrome

In Western societies, constipation remains a major health problem mostly due to refined diet. It is well known that a sufficient amount of dietary fiber is a cornerstone in the prevention and treatment of constipation. The metabolism of flaxseed fiber can be stated as with any dietary fiber. Various reviews and articles have described comprehensively the effects of flax fiber, including gastrointestinal (GI)-motility, constipation, glucose tolerance, hypocholesterolemic effect and fermentation (Mani et al., 2011; Kristensen et al., 2012).

Antioxidant Activity of Flaxseeds

Studies shows that natural products especially from plant sources have the ability to reduce oxidative stress by acting as antioxidants. Natural products especially from plant sources have the ability to reduce oxidative stress by acting as antioxidants (Kasote et al., 2015).

Oxidative stress and inflammation have been recognized as important contributors to the risk of chronic non-communicable diseases. Polyunsaturated fatty acids (PUFAs) may regulate the antioxidant signaling pathway and modulate inflammatory processes. They also influence hepatic lipid metabolism and physiological responses of other organs, including the heart. Longitudinal prospective cohort studies demonstrate that there is an association between moderate intake of the omega-6 PUFA linoleic acid and lower risk of cardiovascular diseases (CVDs), most likely as a result of lower

blood cholesterol concentration. Many studies show that higher intakes of omega-3 PUFAs, especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are associated with a lower incidence of chronic diseases characterized by elevated inflammation, including CVDs (Djuricic and Calder, 2021).

The effect of the ingestion of flax seed powder, known to produce high concentrations of urinary lignans in cycling women. Studies showed that women who supplemented with flaxseed for three cycles showed ovulation associated with longer luteal phase in comparison to others not supplemented with flaxseed who showed 2 out of three anovulatory cycles despite of the non-significant differences in either estradiol or estrone during all phases of the cycle in both groups (Kassem et al., 2015). Tumor and cancer reducing effects Interest in research on the association between flaxseed ingestion and risk of cancer emerged when epidemiologic evidences suggested a beneficial relationship. Research in laboratories has shown that flaxseed inhibits the formation of colon, breast, skin, and lung tumors and also reduces blood vessel cell formation in female rats, all suggesting a protective effect against breast, colon and ovarian cancer (Truan et al., 2012).

Free radicals are formed continuously within the human body during cell respiration. Simultaneously, the body has many mechanisms to get rid of these highly reactive molecules. When the formation of free radicals exceeds the body capacity to get rid of them, oxidative damage occurs. Antioxidants are substance that protect the cells against these free radicals. The consumption of flaxseeds that contain natural antioxidants is thought to be an effective way for reducing the risk of oxidative stress diseases. So the determination of antioxidant content and capacity, there allows the screening of flaxseeds that are probably involved in the prevention or treatment of oxidative stress diseases.

DPPH method was used to find the total antioxidant activity. The radical scavenging activity was determined using Diphenyl Picryl Hydrazyl (DPPH) which is a rapid, simple, inexpensive and widely used method to measure the ability of compounds to act as free radical scavengers or hydrogen donors, and to evaluate antioxidant activity of foods. It can also be used to quantify antioxidants in complex biological systems, for solid or liquid samples. This method is easy and applies to measure the overall antioxidant capacity and the free radical scavenging activity of fruit and vegetable juices (Sendra et al. 2006). This assay has been successfully utilized for investigating antioxidant properties of wheat grain and bran, vegetables, conjugated linoleic acids, herbs, edible seed oils, and flours in several different solvent systems including ethanol, aqueous acetone, methanol, aqueous alcohol and benzene (Kedare and Singh, 2011).

Conclusion

Thus, the rich nutrient profile and health benefits of flaxseed makes it a promising dietary inclusion in the prevention and treatment of diseases. Cost effective dietary supplements may be developed and popularized for improving the quality of life.

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