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**Maneesha Jhariya**

M.Sc. (H. Sc), Department of Food and Nutrition, Govt. M. H. College of Home Science and Science for Women Autonomous, Jabalpur, Madhya Pradesh, India

**Apoorva Soni**

Assistant Professor, Department of Food and Nutrition, Govt. M. H. College of Home Science and Science for Women Autonomous, Jabalpur, Madhya Pradesh, India

**Dr. Rajlakshmi Tripathi**

Principal, Govt. Lalit Kala Mahavidyalaya, Jabalpur, Madhya Pradesh, India

## Flexseed in diet: A strategy to promote human health: A review

Maneesha Jhariya, Apoorva Soni and Dr. Rajlakshmi Tripathi

### Abstract

Alpha linolenic acid, lignan secoisolariciresinol diglucoside, lignan secoisolariciresinol diglucoside, and fibre are all abundant in flaxseed. Through their anti-inflammatory action, anti-oxidative capability, and lipid regulating capabilities, these chemicals provide bioactivity beneficial to the health of both humans and animals. This article discusses the properties of consuming flaxseed or its bioactive ingredients. This review also covers the advantages of giving flaxseed or the specific bioactive components on health and disease. The benefits and drawbacks of dietary flaxseed in relation to various cardiovascular illnesses, cancer, gastrointestinal health, brain development and function, as well as menopausal women's hormonal status, are all comprehensive issues for discussion. Phytochemicals are currently gaining popularity as bioactive dietary components. As consumers become more health concerned, functional foods are becoming a more attractive area of study in food science. Flaxseed is grown around the world for its fibre, oil, medicinal properties, and nutritional value. In this overview, flaxseed's lignans, dietary fibre, and essential fatty acids are examined along with their nutrients, anti-nutrients, functional characteristics, digestion, metabolism, and health effects.

**Keywords:** Flaxseed, functional food, diabetes, menopause, microbiota, cardiovascular disease, and diabetes

### Introduction

Flax (*Linum usitatissimum*), a member of the Lineaceae family, is an annual herb with blue flowers and small, flat seeds that range in colour from golden yellow to reddish brown. The texture and flavour of flaxseed are crisp (Morris 2007; Rubilar *et al.* 2010) [101, 105].

An impressive and expanding body of research on dietary flaxseed supports its efficacy in treating a number of medical disorders. Today's knowledge of flaxseed's health advantages and how to take it to get those benefits is vastly different from that of the late 20th century, when there was little information available. The amount of research on the effects of dietary flaxseed has drastically risen. We now understand the diseases that flaxseed can treat or prevent, the health benefits that flaxseed can offer through food, the bioactive components of flaxseed that frequently offer these health benefits, and the forms of flaxseed that the body needs to absorb these bioactives. Animal studies have yielded some, if scant, information on the influence of disease.

### Functional properties of flaxseed constituents

Functional ingredient	Applications	References
Mucilage	Emulsifier & stabilizer in sauces, sausages, meat emulsions, salad dressings	[Stewart and Mazza 2000] [91]
	Anti-staling agent in baked products	[Lipilina and Ganji 2009] [92]
	Improves cooking quality of noodles	[Kishk <i>et al.</i> 2011] [93]
	Functional food ingredient (interaction of mucilage and protein regulate blood glucose level)	[Singer <i>et al.</i> 2011] [94]
sProtein	Stabilizer & emulsifier in ice cream, sauces and meat emulsions	[Martinez-Flores <i>et al.</i> 2006] [95]
	Antifungal property	[Xu <i>et al.</i> 2008a, b] [96]
	Viscoelastic texture to extruded pastes for breakfast cereals and snacks	[Wu <i>et al.</i> 2010] [97]
	Enhances nutrition in gluten free meal	[Gambus <i>et al.</i> 2009] [98]
	Egg and gelatin substitute in baked goods and ice cream	[Shearer and Davies 2005] [99]
	Functional food ingredient	[Moller <i>et al.</i> 2008] [100]

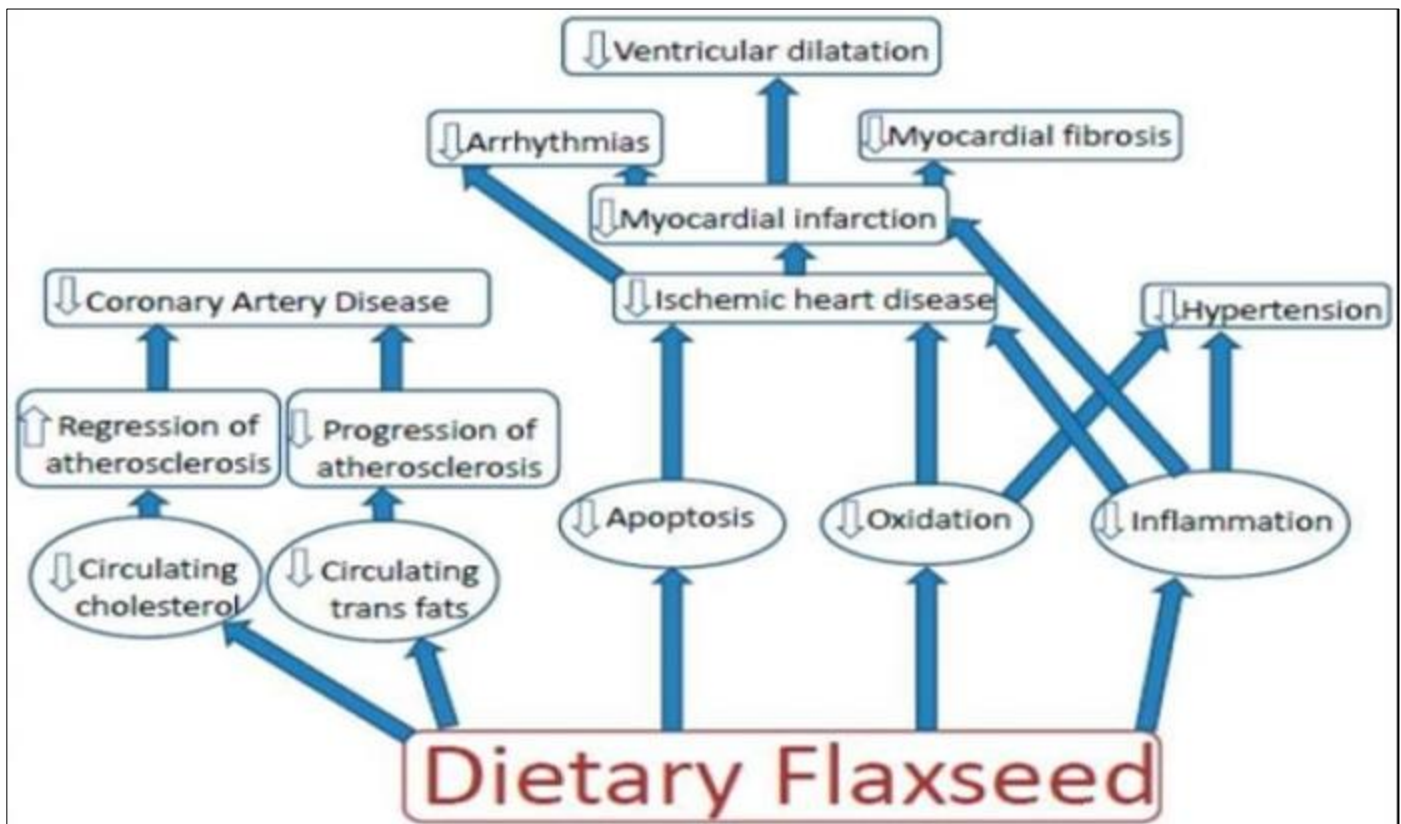
**Corresponding Author:****Maneesha Jhariya**

M.Sc. (H. Sc), Department of Food and Nutrition, Govt. M. H. College of Home Science and Science for Women Autonomous, Jabalpur, Madhya Pradesh, India

**The dietary use of flaxseed:** 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 CCl<sub>4</sub> intoxicated rats, lipid peroxidation products were neutralized by flaxseed lignans (Shakir and

Madhusudan 2007) <sup>[102]</sup>.

**Flaxseeds on Cardiovascular Disease:** One of the areas of dietary flaxseed research that has received the most attention is its influence on markers associated with cardiovascular disease.



**Image Source:** 16. Dupasquier C.M.C., Dibrov E., Kneesh A.L., Cheung P.K.M., Lee K.G.Y., Alexander H.K., Yeganeh B., Moghadasian M.H., Pierce G.N. Dietary flaxseed inhibits atherosclerosis in the LDL receptor deficient mouse in part through anti-proliferative and anti-inflammatory actions. *Am. J. Physiol.* 2007;293:H2394–H2402.

**Fig 1:** The effect of dietary flaxseed on the various types of cardiovascular disease. Arrows going up denote an Increase in a specific parameter whereas arrows going down denote a decrease in a specific parameter.

In animal models of heart disease, dietary flaxseed has decreased the progression of atherosclerosis induced by high dietary cholesterol or high dietary trans-fat content [*Am. J. Physiol. et al.* (2006) <sup>[15]</sup>, likely via an anti-inflammatory action provided through its ALA content [*Am. J. Physiol. et al.* (2007) <sup>[103]</sup>]. Depending upon the animal species, flaxseed may (mice and rats) or may not (rabbits) lower circulating cholesterol levels. [Dupasquier C.M.C. Parikh M. *et al.* (2007) <sup>[103]</sup>. Flaxseed can also lower circulating Trans fats levels [*Am. J. Physiol. et al.* (2007) <sup>[103]</sup>. In a stable, established atherosclerotic plaque, supplementation of the diet with flaxseed can also regress atherosclerosis [Francis A.A., Austria *et al.* (2013) <sup>[19]</sup>.

Ischemic reperfusion challenge to isolated hearts can induce arrhythmias. Rabbits on a flaxseed supplemented diet prior to

#### Dietary Flaxseed and Diabetes

Flaxseed also impacts another major disease that is growing in incidence across the globe: diabetes. Flaxseed supplementation reduced blood glucose in subjects with type 2 diabetes [Soltanian N *et al.* (2018) <sup>[30]</sup>. And lowered blood glucose in subjects with prediabetes [Hutchins A.M. *et al.* (2013) <sup>[32]</sup>]. Flaxseed derived gum and lignan supplement also decreased blood glucose in subjects with Type 2 diabetes [Thakur G. *et al.* (2009) <sup>[33]</sup>. Pre-clinical studies have

reported anti-hyperglycemic effects of the flaxseed lignan SDG in animals with Type I diabetes. [Prasad K *et al.* (2000) <sup>[35]</sup>. Whether SDG or flaxseed supplementation improves glycemic control in human subjects with Type 1 diabetes remains unknown and could be a topic of experimentation in the future.

#### Flaxseed and the Brain in Diet

Omega-3 fatty acids from marine sources are well established to have a crucial function in brain development. [Lauritzen L *et al.* (2016) <sup>[49]</sup>. The omega-3 fatty acids docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) have been the main focus of this work in the past. EPA seems to modulate behavior and mood, whereas studies has proven a vital role for DHA in pre- and post-natal brain development. [Lauritzen L (2016) <sup>[49]</sup>. DHA deficiency has been linked to worse performance on learning and spatial these findings imply that the brain might benefit similarly from the omega-3 fatty acid ALA, which is abundant in flaxseed. Rat moms who consumed flaxseed throughout pregnancy gave birth to pups with larger brains.

#### Consumption and Female Hormonal Status

In addition to providing protection against menopausal symptoms, dietary flaxseed may also do so. [Landete J.M. *et*

al. (2016)]<sup>[59]</sup>. Numerous studies have looked at the impact of flaxseed or its bioactive components on post-menopausal women's quality of life, as well as the frequency and intensity of hot flashes. Certain flaxseed metabolites' estrogenic activity revealed a possible beneficial influence on certain post-menopausal symptoms. In a study of 140 postmenopausal women, those who had a flaxseed supplemented diet reported fewer menopausal symptoms and improved quality of life [Cetisli N.E., Saruhan A. *et al.* (2015)]<sup>[60]</sup>. There was a significant reduction in menopausal.

### Flaxseed in the Diet and Skin Health

A 12-week, randomised, double-blinded trial on healthy female volunteers with sensitive skin revealed that consuming flaxseed oil enhanced certain skin characteristics. Skin sensitivity, transepidermal water loss, skin roughness, and skin scaling were significantly decreased while skin hydration and smoothness increased. [Neukam K. *et al.* (2011)]<sup>[70]</sup>. The primary bioactive responsible for these effects on skin and ageing was found to be ALA. Proinflammatory oxylinpids such 5-HETE, 9, 10, 13-TriHOME, and 9, 12-13-TriHOME are more prevalent in older people than in a younger group, which may help to explain why there is more inflammation in this older population [Caligiuri S.P.B *et al.* (2014)]<sup>[25]</sup>. Flaxseed consumption has been demonstrated to balance pro- and anti-inflammatory oxylinpids, which may have a positive impact on ageing.

[1-3 Mihir Parikh Thane Maddaford, 1, 2, and 3 J. Alejandra Austria, 1, 2, and 3 Aliani, Michel, 2, 4, Grant N. Pierce, Thomas Netticadan, and others<sup>1,2,3,\*</sup> ]

Flaxseed has generated interest in diets as a constipation remedy. In the initial trial [Soltanian N *et al.* (2018)]<sup>[30]</sup>, Type 2 diabetic patients who were constipated consumed flaxseed that had been baked into cookies. They discovered that flaxseed decreased the symptoms of constipation, weight, fasting plasma glucose, triglycerides, and levels of LDL and HDL cholesterol. In a subsequent trial with the same patient population, flaxseed once again improved all of these variables and, critically, outperformed psyllium in terms of its ability to lessen constipation symptoms. [Soltanian N *et al.* (2019)]<sup>[85]</sup>. Further study is needed to determine whether flaxseed can help with irritable bowel syndrome symptoms. [Cockerell K.M *et al.* (2012)]<sup>[86]</sup>. Additionally helpful in easing experimental diarrhoea was flaxseed oil [Hanif Pz. A., *et al.* (2015)]<sup>[87]</sup>.

### Flaxseed Consumption and Digestive Health

The research community is paying more and more attention to how the microbiome affects human and animal health [Ettinger G *et al.* (2014)]<sup>[72]</sup>. Our knowledge of how dietary flaxseed affects the gut flora in both healthy and diseased individuals, meanwhile, is limited and enterolactone from SDG the best [Thompson L.U., *et al.* (1991)]<sup>[73]</sup>. Specific intestinal bacteria, such as Ruminococcus, do biotransformation to carry out this intestinal metabolism [Wang C.Z. *et al.* (2010)]<sup>[97]</sup>. Flaxseed has generated interest in diets as a constipation remedy. In the initial trial [Soltanian N *et al.* (2018)]<sup>[30]</sup>, Type 2 diabetic patients who were constipated consumed flaxseed that had been baked into cookies. They discovered that flaxseed decreased the symptoms of constipation, weight, fasting plasma glucose, triglycerides, and levels of LDL and HDL cholesterol. In a subsequent trial with the same patient population, flaxseed once again improved all of these variables and, critically, outperformed psyllium in terms of its ability to lessen

constipation symptoms [Soltanian N *et al.* (2018)]<sup>[30]</sup>. Further study is needed to determine whether flaxseed can help with irritable bowel syndrome symptoms. [Cockerell K.M *et al.* (2012)]<sup>[86]</sup>. Additionally helpful in easing experimental diarrhoea was flaxseed oil [Hanif P.A *et al.* (2015)]<sup>[87]</sup>. When it comes to boosting faecal production during constipation, flaxseed has a very clear mechanism of action.

### The dangers of flaxseed

Despite the fact that no toxicity has ever been associated with the dietary supplementation of flaxseed in clinical research, various flaxseed constituents, such as cyanogenic glycosides and linatine, have been discovered as potentially harmful substances. Nitrogenous secondary plant metabolites known as cyanogenic glycosides include linamarin, linustatin, neolinustatin, lotaustralin, and amygdalin. [Parikh M. *et al.* (2018)]<sup>[3]</sup>. Apples, spinach, and cassavas are just a few of the foods that contain these components in addition to flaxseed [Bolarinwa I.F *et al.* (2015)]<sup>[88]</sup>. Intestinal -glycosidase changes the glycoside into cyanohydrin, which then breaks down into hydrogen cyanide [Cressey P. *et al.* (2019)]<sup>[90]</sup>. Linustatinase and linamarase-glycosidase, two different enzymes, catalyse this reaction in flaxse.

### Conclusions

The body can benefit greatly from adding milled flaxseed to the diet as a supplement. Although diabetes and gastrointestinal health have been open to the positive benefits of dietary flaxseed, cardiovascular disease and cancer are perhaps the most explored areas that have demonstrated convincing evidence of a favourable action for dietary flaxseed. Although more research is needed to draw firm conclusions about other aspects of human health, the early results are encouraging. With little to no evidence of toxicity for dietary supplementation with flaxseed, there doesn't seem to be much of a case against include it in a daily diet.

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