



Flaxseed in the Reduction of Diabetes and Obesity

By Jennifer Adolphe, PhD, RD and Kelley Fitzpatrick, MSc

Diabetes and obesity are global epidemics with considerable social and economic consequences.

Flaxseed contains key nutrients to reduce diabetes and obesity: lignans, alpha-linolenic acid, and dietary fibre.

Diets containing flaxseed or its individual components are associated with improved blood glucose control and insulin sensitivity, increased satiety, and reduced energy intake.

Diabetes is characterized by hyperglycemia due to defects in insulin metabolism.¹ Chronic hyperglycemia results in organ damage, particularly to the eyes, kidneys, heart and vasculature.¹ Type 1 diabetes is due to an absolute deficiency of insulin secretion, whereas type 2 diabetes is caused by a combination of insulin resistance and inadequate compensatory insulin secretion.¹ Type 2 diabetes is the more common form of the disease, accounting for 90-95% of cases.¹

The number of adults with diabetes is increasing rapidly and is now estimated to be 8.3% of the global population, or 387 million people.² In Canada, diabetes prevalence is projected to reach 3.2 million people in 2016.³ In the United States, 29.1 million people or 9.3% of the population have diabetes, which resulted in an estimated expenditure of \$245 billion in 2012.⁴

Obesity is a global epidemic and a risk factor for numerous chronic diseases, including type 2 diabetes, cardiovascular disease, and some cancers. In 2007-2009, the prevalence of obesity in Canada and the United States was 24.1% and 34.4%, respectively.⁵ The worldwide prevalence of overweight and obesity has almost doubled over the past three decades.⁶

Nutrition: A key strategy for reducing the risk of diabetes and obesity

The Canadian Diabetes Association recommends that people with diabetes receive nutrition counselling by a registered dietitian followed by frequent follow-up to improve dietary adherence.⁸ Nutrition therapy aimed at controlling blood glucose levels can significantly lower glycated hemoglobin (hemoglobin A_{1c}) by approximately 1 - 2 % within three to six months.⁷ Glycated hemoglobin occurs when glucose molecules attach to the hemoglobin in red blood cells. A hemoglobin A_{1c} value of $\geq 6.5\%$ is a criterion for the diagnosis of diabetes.⁷

Consumption of nutrient-rich, high fibre foods that contribute to satiety may help with weight loss or the prevention of weight gain.⁹ Modest weight loss has been shown to significantly improve insulin sensitivity.⁸

Flaxseed is packed with nutrients to fight diabetes and obesity

For a tiny seed, flax provides a wealth of nutrition for the fight against diabetes and obesity:¹⁰

Lignans: flaxseed is the richest source of plant lignans, particularly secoisolariciresinol diglucoside (SDG), which is converted by intestinal bacteria to the mammalian lignans secoisolariciresinol (SECO), enterodiol and enterolactone. The approximate SDG content in flaxseed is 375 mg/100 g.

Omega-3 fatty acids: flaxseed is the richest plant source of the essential fatty acid α -linolenic acid (ALA). Approximately 55-57% of the fatty acids in flaxseed are ALA.

Dietary fibre: flaxseed is a rich source of dietary fibre, including both insoluble and soluble fibre. Flaxseed provides 4 g of fibre in a 2 tablespoon serving.



Flax Scones recipe at HealthyFlax.org

Lignans

Lignans are a type of phytoestrogen that are able to bind to estrogen receptors due to their structural similarity to estradiol, the major form of estrogen in the body.¹⁰ Animal studies provide evidence that flaxseed lignans offer protection against diabetes. In female rats prone to diabetes, only 20% of rats receiving SDG progressed to diabetes, whereas all untreated rats developed the disease.¹¹ SDG has also been shown to reduce visceral (abdominal) fat, a risk factor for metabolic syndrome and diabetes, in mice receiving a high fat diet with SDG compared to mice consuming the same diet without SDG.¹²

Human clinical trials provide support for a beneficial role for lignans in decreasing the risk of diabetes. People with type 2 diabetes who received a flaxseed lignan supplement for 12 weeks had significantly lower hemoglobin A_{1c} compared to placebo.¹³ In addition, flaxseed lignan (543 mg/d) improved metabolic syndrome composite score in men after six months of treatment compared to those receiving a placebo.¹⁴ Metabolic syndrome is characterized by a cluster of risk factors (central adiposity; increased triglycerides, blood pressure and inflammation; and decreased HDL cholesterol) that increase the risk of developing insulin resistance and cardiovascular disease.

Phytoestrogens, such as flaxseed lignans, have been proposed to protect against diabetes and metabolic syndrome in several ways, including down-regulating pro-inflammatory molecules, improving insulin sensitivity, exerting antioxidant effects, and increasing energy expenditure through a series of complex mechanisms.¹⁵ In addition, flaxseed lignans may help to control blood glucose levels via their effect on enzymes involved in maintaining normoglycemia.¹⁰

α -Linolenic Acid

Flaxseed oil has a unique mix of fatty acids. It is low in saturates (less than 9% of total fatty acids) and contains the essential polyunsaturated fatty acids omega-3 ALA and omega-6 linoleic acid

YELLOW FLAXSEED



YELLOW GROUND FLAXSEED



BROWN FLAXSEED



BROWN GROUND FLAXSEED



(LA). Diabetes increases the risk of coronary artery disease by 2 to 3 times, leading to recommendations for restricting saturated fat to <7% of energy and trans fatty acid intake to be as low as possible.^{7,8} Polyunsaturated fats, such as those found in flaxseed, should be included in the diet at up to 10% of total energy intake.⁷

Dietary intake of ALA is associated with a modest reduction in diabetes risk.¹⁶ In a systematic review and meta-analysis of prospective studies examining the relationship between omega-3 fatty acid intake and diabetes risk, both dietary ALA intake and circulating ALA biomarkers were associated with a trend towards lower risk of diabetes.¹⁷ One of the mechanisms by which ALA may act to counter the disease is by increasing insulin sensitivity.¹⁶

Obesity is recognized as a state of low-grade, chronic inflammation. ALA may protect against inflammation through its effects on oxylipins and eicosanoids. Oxylipins are formed from fatty acids and possess either pro- or anti-inflammatory properties, which depend partly on the type of dietary fatty acid precursor.¹⁸ Pro-inflammatory oxylipins have been shown to increase with age in humans, which may contribute to increased risk of many chronic diseases.¹⁸ After ingestion of 30 g/day of milled flaxseed for four weeks, the oxylipin profile of older individuals was modified to resemble that of young healthy subjects.¹⁸

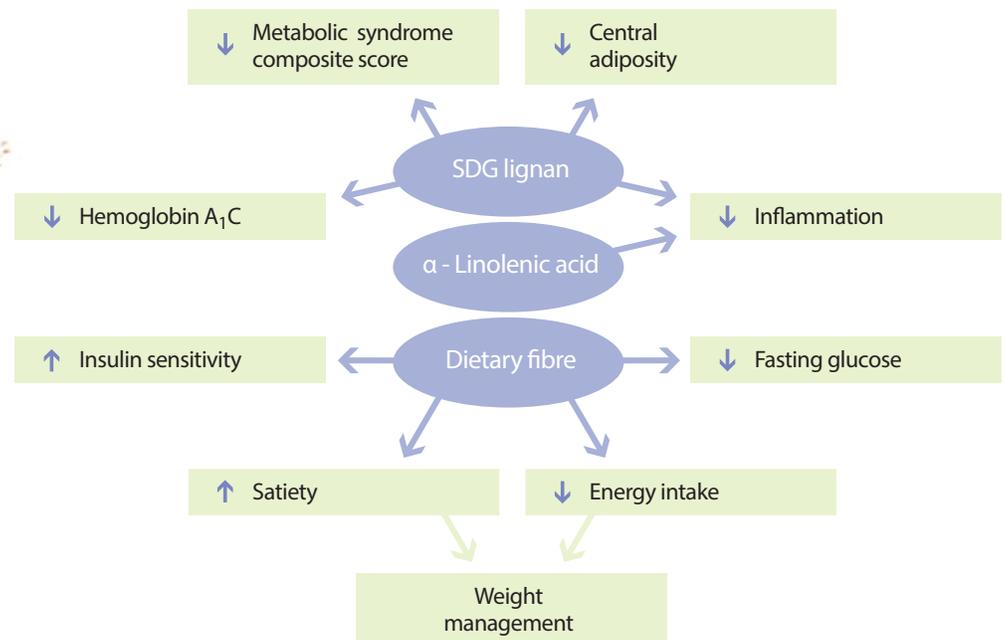
Eicosanoids are a subset of oxylipins and are hormone-like substances that affect inflammation. They are produced from both ALA (anti-inflammatory) and LA (mostly pro-inflammatory). The typical Western diet is high in LA and low in ALA. This ratio can be shifted to guard against inflammation by increasing dietary ALA intake from flaxseed.¹⁸

Dietary Fibre

Flaxseed is a rich source of dietary fibre, providing 16% of the recommended daily intake in a 2 tablespoon serving. A high fibre diet (25-50 g/day or 15-25 g/1000 kcal) is likely the most effective diet for individuals with diabetes due to the effect of fibre in reducing glycemia, insulinemia and lipemia.^{8,19} Fibre, particularly soluble fibre, may help to promote weight loss or prevent weight gain by absorbing large quantities of water to induce a feeling of fullness and delay gastric emptying.²⁰

The effect of flaxseed soluble fibre on blood glucose levels in patients with type 2 diabetes has been examined. Participants were fed chapatti flatbreads with or without 5 g of flaxseed mucilage.²¹ Fasting blood glucose significantly decreased in the flaxseed group after three months (8.4 ± 0.4mmol/L at baseline; 7.6 ± 0.4 mmol/L after treatment). Insulin sensitivity also improved in patients receiving flaxseed mucilage.²¹

Figure 1. Potential mechanisms by which flaxseed protects against diabetes and obesity



HealthyFlax.org is the source of information on the health benefits and uses of whole flaxseed, ground flaxseed and flaxseed oil. Our website includes recipes, nutritional evidence, facts and news about flaxseed in all its forms. HealthyFlax.org is supported by Canada's flax growers, processors, food manufacturers and governments. For more information, email us at info@healthyflax.org



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High fibre diets are associated with increased satiety, reduced hunger and energy intake, and weight loss. Results of a systematic review reported that high fibre diets (providing an additional 14 g/day of fibre) among overweight and obese individuals reduced energy intakes to 82% of control and resulted in an average weight loss of 2.4 kg.²²

Supplements providing 2.5 g of flaxseed soluble fibre in a beverage or tablet form significantly reduced energy intake compared to control (702 vs. 768 kcal).²³ Subjective measures of satiety and fullness increased, while hunger and prospective food intake decreased.²³ Purified flaxseed dietary fibre lowered post-prandial insulin following meals in comparison to either no or whole flaxseed.²⁴ Satiety and fullness were higher after the flaxseed fibre treatment compared to control.²⁴ Together these studies suggest that flaxseed fibre reduces appetite, potentially leading to improved weight management over the long term.

Whole Flaxseed

While each of the individual nutrients in flaxseed appears to lower the risk of diabetes and obesity, together in whole flaxseed they may provide the most benefit (*Figure 1*).

In a randomized cross-over study, overweight or obese men and women with pre-diabetes who consumed 13 g of ground flaxseed for 12 weeks showed improved fasting insulin and glucose as well as insulin sensitivity compared to controls.²⁵ Following one month on a 10 g/day supplement of ground flaxseed, fasting blood glucose and hemoglobin A_{1c} were found to be significantly reduced in type 2 diabetics.²⁶

An approximate 4% gain in body weight and BMI from baseline was reported in a control group not fed flaxseed compared to individuals with type 2 diabetes that consumed 32 g/day milled flaxseed or 13 g/day flaxseed oil for 12 weeks.²⁷ In addition, the waist circumference of those fed milled flaxseed decreased by 5 cm during the treatment period.²⁷

Together lignans, α -linolenic acid, and dietary fibre make flax a tiny seed that packs a big nutritional punch in the fight against diabetes and obesity.

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