

Effectiveness of Adding Flaxseed to Type 2 Diabetic Patient's Regimen

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Abstract

Background and Aims: Flaxseed is a promising alternative reducing the risk of diseases associated with obesity. The purpose of this study is to determine the effect of supplemented bakery with flaxseed or flaxseed oil on type 2 diabetic patients

Materials and Methods: Ninety type 2 diabetic on oral hypoglycemic (body weight, fasting, post prandial blood glucose, cholesterol, LDL, HDL, Triglycerides, VLDL and leptin) were recorded at base line, and after twelve weeks. Participants divided into 3 groups. Group 1 (control): Consists of 30 patients on regimen diet with type 2 diabetes who received regimen diet 1350 kcal. Group 2: Consists of 30 patients with type 2 diabetes and following regimen diet same as group (1) plus a dose of flaxseed oil bakery regimen diet for twelve weeks. Group (3): Consists of 30 subjects with type 2 diabetes on regimen diet the same as group (1) plus supplementation with flaxseed bakery product for twelve weeks.

Results: After twelve weeks significant changes in group 2 and 3 Versus control in BMI (0.05, 0.03) fasting ($p < 0.001$), post prandial glucose (0.03, 0.02, 0.001), HA1c (0.02, 0.01), cholesterol (0.024, < 0.001 , 0.01), triglycerides (< 0.001), LDL (0.05, 0.001, 0.01), VLDL (< 0.001) and leptin (< 0.001).

Conclusion: Regimen diet containing supplemented bakery with flaxseed or flaxseed oil for 12 weeks decrease BMI, blood glucose, lipid profile in type 2 diabetics, thus incorporating flaxseed in bakery is recommended.

Keywords: Flaxseed; Diabetes; Lipid profile; Nutraceuticals

Introduction

Obesity is considered one of the major causes of diabetes as it increases insulin resistance [1]. Obesity prevalence ranges from 56% in urban Egypt to 6% in rural Egypt in men. The higher the socioeconomic class, the higher prevalence of obesity [2]. Obesity is a world-wide epidemic problem and a risk factor for non-communicable diseases (NCD) associated with high morbidity and mortality [3].

Flaxseed contains 40% lipids (70-73% is polyunsaturated), α -linolenic acid represents more than 50% of this fat. It is also the richest source of the lignan secoisolariciresinol diglucoside, which is metabolized to enterodiol and enterolactone [4]. Accordingly, the interest in studies of the functional effects of flaxseed is increasing. Flaxseed is a promising alternative to reduce the risk of diseases associated with increased body weight [5] as well as many types of cancers (breast, endometrial and colon cancers).

Lignans also have preventive effect on diabetes and recent advances in the functional characterization of lignan biosynthetic enzymes have suggested methods for metabolic engineering of lignan biosynthesis cascades for efficient lignan production from plants, including plant cell/organ cultures [6].

The purpose of this study was to find out the effect of addition of flaxseed (FXS) or flaxseed oil (FXO) to bakery products on blood glucose, body mass index, serum lipids in type 2 diabetic patients.

Materials and Methods

Experimental design

A randomized cross-sectional study including 90 patients with type 2 diabetes mellitus ranging 5-7 years duration on oral hypoglycemic (Metformin 500 mg/l) 3 times/day (Alexandria Co, Egypt), were selected from Kasr El Aini hospital out-patient clinic, Diabetes and Endocrinology unit. Age ranged from 35-45 years old. Body mass index of $\pm 29 \text{ kg/m}^2$

Exclusion criteria

- Previous history of myocardial infarction or cerebrovascular accidents.
- Existing renal, gastrointestinal or liver diseases.
- Pregnancy and breast feeding.
- Nutritional disorders.
- Any allergy or intolerance to flaxseed.

Participants were divided into 3 groups:

Group (1): Consists of 30 patients with type 2 diabetes who received regimen diet 1350 kcal (in the form of 50% carbohydrates, 30% fats and 20% proteins).

Group (2): Consists of 30 patients with type 2 diabetes and following regimen diet same as group (1) plus a dose of flaxseed oil bakery product added into their regimen diet for 6 days per week in amount of 13 gm/day, providing 7.4 g ALA/day in 12 weeks.

Group (3): Consists of 30 subjects with type 2 diabetes on regimen diet the same as group (1) plus supplementation with flaxseed bakery product added into their regimen diet for 6 days per week (FXS) 32 g flaxseed/day providing 7.4 g ALA/day in 12 weeks.

Preparing and baking Techniques of supplemented bakery with flaxseed oil or flaxseed:

Bread samples were prepared at agriculture research center according to the common method described by (Khorshid, et al) [7]. Sieved soft wheat flour 82% (1 kg) and its blends with (288 gm) of flaxseed or (132 gm) of flaxseed oil, were mixed with (20 gm) bakery yeast, (10 gm) salt and (10 gm) sugar and water (half to 1liter). The previous formula was mechanically mixed, using mixer. The mixer bowl was covered and left for 30-45 min at 28-30°C to rest. The rested dough was divided into 80 pieces of suede heel or 18 pieces of Kaiser Rolls. Baking was carried out in oven 230 for (30-45 minutes).

The products were prepared 2 times per week (Sundays and Tuesdays) in the 'Food Agricultural Technology Research Center'– "National Research Institute" and distributed to the participants who

were instructed to consume the full portion and to return the leftovers which were identified and taken to the 'Diet Technique Laboratory' to be weighed, and the quantities actually consumed were recorded in specific spreadsheets for subsequent calculation of the amount of consumed flaxseed.

Statistical methodology

Data was coded and entered using the statistical package SPSS version 21. Data was summarized using mean and standard deviation. Comparisons between groups were done using analysis of variance (ANOVA) with multiple comparisons post hoc test. Comparison between values measured at the start and values measured after 3 months in each group was done using paired t test. P-values less than 0.05 were considered as statistically significant.

Ethical approval

The study was approved by the appropriate ethics committee and had been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki with its later amendments and all procedures involving human subjects and specific national laws have been observed too. Oral and written consents were taken from patients.

Results

Epidemiology of different groups of the study is shown in Table 1 indicates no significant difference in BMI, baseline fasting blood glucose and lipid profile between the 3 groups.

Variable	Group (1)	Group (2)	Group (3)	P	P	P
				1,2	1,3	2,3
BMI (kg/m ²)	29.35 ± 2.76	29.84 ± 4.59	29.40 ± 3.4	0.9	1	1
Fasting glucose (mg/dl)	182.50 ± 10.92	226.88 ± 45.48	212.68 ± 29	0.168	1	0.233
Post prandial glucose (mg/dl)	268.39 ± 8.1	299.98 ± 49	281.96 ± 32	0.09	0.242	0.13
HA1C (%)	8.14 ± 0.30	7.93 ± 1.16	7.35 ± 1.55	0.17	0.12	1
Cholesterol (mg/dl)	290.20 ± 6.89	275.85 ± 34.18	256.95 ± 25	0.09	0.07	0.07
Triglycerides (mg/dl)	217.21 ± 40	190.98 ± 8.1	192.98 ± 4	0.144	0.08	0.9
HDL (mg/dl)	48.32 ± 2.81	43.82 ± 6.11	41.89 ± 27	0.9	0.8	0.9
LDL (mg/dl)	228.28 ± 6.7	192.96 ± 9.04	210.52 ± 26	0.19	0.9	0.8
VLDL (mg/dl)	23.55 ± 2.14	18.36 ± 3.25	14.62 ± 2.5	0.231	0.07	0.93
Leptin (mcg/l)	12.34 ± 0.30	11.54 ± 1.84	7.14 ± 1.2	1	0.07	0.07

Table 1: Comparison between control (group 1) and patients groups (2 and 3) regarding BMI and laboratory findings at the start of study.

Table 2 is showing the follow up results for all groups after 12 weeks. After twelve weeks significant changes in group 2 and 3 versus control in BMI (0.05, 0.03) fasting (p<0.001), post prandial glucose (0.03, 0.02, 0.001), HA1c (0.02, 0.01), cholesterol (0.024, <0.001, 0.01), triglycerides (<0.001), LDL (0.05, 0.001, 0.01), VLDL (<0.001) and leptin (<0.001).

In our study, regimen diet supplemented with Flaxseed or Flaxseed oil induced significant decrease in BMI as compared to the group treated with regimen diet only.

Variable	Group(1)	Group(2)	Group(3)	P	P	P
				1,2	1,3	2,3
BMI (kg/m ²)	31.80 ± 3.2	23.35 ± 2.76	21.45 ± 3.1	0.05	0.03	0.1
Fasting glucose (mg/dl)	227.20 ± 22.3	162.61 ± 12.45	127.30 ± 16	<0.001	<0.001	<0.001
Post prandial glucose (mg/dl)	291.80 ± 23.6	237.02 ± 11	180.22 ± 16	0.03	0.02	0.001
HA1C (%)	8.14 ± 0.73	6.93 ± 0.30	5.35 ± 1.02	0.02	0.01	0.9
Cholesterol (mg/dl)	307.70 ± 13.1	247.70 ± 6.89	170.77 ± 16	0.024	<0.001	0.01
Triglycerides (mg/dl)	178 ± 22.13	171.60 ± 13	75.27 ± 1	0.92	1	<0.001
HDL (mg/dl)	43.98 ± 3.53	50.23 ± 3.89	47.61 ± 1.9	0.9	1	0.93
LDL (mg/dl)	240.64 ± 12.9	178.06 ± 12.6	135.83 ± 11	0.05	0.001	0.01
VLDL (mg/dl)	22.73 ± 1.14	14.31 ± 0.14	14.00 ± 1.6	<0.001	<0.001	1
Leptin (mcg/l)	12.22 ± 0.63	6.40 ± 0.48	7.47 ± 1.2	0.001	<0.001	1

Table 2: Comparison between control group (Group 1) and patients groups (2 and 3) regarding BMI and laboratory findings after 12 weeks of Flaxseed diet.

Discussion

Flaxseed is the richest source of dietary secoisolariciresinol diglucoside (SDG). The main Lignan in flaxseed [8] stored in the seed coat following ingestion is converted into enterodiol [9] and enterolactone [10] after ingestion by human intestinal microbiota. Those metabolites are responsible for a large part of the health benefits of flaxseed.

Thompson, et al. [11] reported that flaxseed nutritional value per 100 g is energy equivalent to 534 Kcal, carbohydrates 28.889, sugars 1.55 g, dietary fiber 27.39, fat 42.16 g, protein 18.24 g, thiamin (vi+B1) 1.644 mg, riboflavin (vi+B2) 0.161 mg, niacin 3.08 mg, pantothenic acid (B5) 0.985 mg, vitamin B6 0.0 mg, vitamin C 0.6 mg, calcium 25 mg, iron 5.73 mg, magnesium 392 mg, phosphorus, 642 mg potassium 813 mg and zinc 4.34 mg respectively [11,12].

Three natural phenolic glucosides, secoisolariciresinol diglucoside, P-Coumaric acid. Glucoside and Ferulic acid glucoside flaxseed can rancid at room temperature in one week [13] resulting in instability of the active components, thus we chose to incorporate FX and FXO in bakery.

Flaxseed is incorporated in various bakery products [14] such as cookies [15], Chinese steamed bread [16], rice paper [17] and flaxseed-fortified macaroni [18].

Different studies showed similar results to our results in terms of blood glucose, lipid profile and BMI [19-21], however, FXS or FXO were not an ingredient of bakery products. We think that it is more practical especially in low income countries in which the bread is the essential food.

Couto and Wichmann indicated that 2 month treatment with 10 and 20 g/d of flaxseed reduced BMI, waist circumference, lipid profile in overweight woman over 19 years. It is not known whether flaxseed could benefit younger population as adolescents [20].

In a study done by Barre for Sixteen patients with type 2 diabetes, a dose of 600 mg secoisolariciresinol diglucoside (SDG)/day for 3

months reduced central obesity gain as measured by waist circumference, decreased fasting plasma glucose, HA1c (decrease of 0.11 HA1c percentage points), inflammation (c-reactive protein (CRP) and significantly increased bleeding time thus reducing the prothrombotic state and interleukin-6 (IL-6) [21].

The mechanisms by which flaxseed exerts its effect on glycemic control has not been fully identified but suggested theories include:

Flaxseed may delay the development of T2DM in Zucker rats, hypoglycemic effect due to its antioxidant activity [22]

In humans, it controls the secretion of a glucagons-like peptide-1 (GLP-1) by activating the extra cellular signal regulated kinase (ERK) pathway, thereby enhancing the secretion of insulin [23].

Ghafooyunissa et al. [24] suggested that a role for 18:3 n-3 in the prevention of insulin resistance and improving insulin action in adipocytes by enhancing glucose transport and inhibiting lipolysis. Wang et al. [25] reported that α-linolenic acid increases peripheral insulin sensitivity in obese patients thus aids in the prevention and treatment of type 2 diabetes mellitus and atherosclerotic vascular diseases.

Flaxseed influences control blood glucose levels and inflammatory biomarkers in obese glucose intolerant people [26-28].

In addition flaxseed contains soluble viscous fibers that lower the glucose response to carbohydrate containing food by delaying gastric emptying and glucose absorption [29].

Flaxseed has potential role on omega 3 fatty acids, reduced lymphocyte proliferation and Th1 cell development, lowered circulating levels of leptin [29-31].

Baranowski et al. found that the dietary intervention with alpha linolic acid (ALA-rich Flaxseed oil in obese zucker rats induced decrease in adipocyte hypertrophy, protein levels of inflammatory markers MCP-1 and TNF-α and T-cell infiltration in adipose tissue [29].

Jufuri et al. reported the reduction in adipocyte size and a decrease in T-cell infiltration in obese rats fed ALA-rich flaxseed oil encouraging the evidence for the health benefits of plant-based omega 3 fatty acids [31-34].

Taylor et al. mentioned that milled flaxseed and flaxseed oil intake possibly prevent weight gain by flax consumption. The waist circumference of FXS group decreased by 5 cm during the treatment [33].

Daleprane et al. [34] demonstrated 18% decrease in triglyceride levels when patients ingested 17.5 g of ALA/day over a six week intervention study. (Prasad, 2005), (Marpalle, P 2014) reported that total cholesterol decreased by 20% and LDL-c decreased by 14%, whereas HDL-c increased by 30% in hypercholesterolemic rabbits fed flax SDG/lignan complex.

Wang et al. and Fukumitsu et al. indicated that a low dose of SDG (100 mg) promotes blood cholesterol lowering effect in moderately hypercholesterolemic men [25,35].

Zhang et al. administered a dose of 600 mg/day SDG for 8 weeks found a decrease in cholesterol, LDL-c and the total cholesterol: HDL-c ratio in humans with hypercholesterolemia and hypertriglyceridemia [36].

Fukumitsu et al. found no change in any lipid parameters with 20 mg/day SDG administered in the form of flaxseed lignan extract for 12 weeks but a drop in the LDL-c-to-HDLc ratio relative to placebo [35].

Abdelkarem and Fadda observed there was a significant increase in serum high density lipoprotein cholesterol (HDL-c) in hyperglycemic rats after 4 weeks of feeding flaxseed (50 mg/ kg) [8].

Flaxseed is considered one of the "nutraceuticals" as it is a type of food and at the same time, has health benefits and medical effect. That is in terms of controlling and regulating blood sugar and serum lipid when it is added to diabetic patient food regimen. Secondary to that, it can effectively decrease the risk of developing cardiovascular disease. Many studies still need to find out the ideal dose that should be used for maximum benefit [37].

Conclusion

For type 2 diabetic patients who are following a low calorie diet, adding bakery products with (FXS) or (FXO), is convenient and beneficial. This regime is helpful to decrease BMI, serum blood glucose and lipid profile and at the same time it will minimize the need for poly-medications.

There is no conflict of interest.

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