Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 5 Issue 7 July 2021

Research Article

Effect of Ground Flaxseed Intake on Lipidic Profile in Subjects with Dyslipidemic with and without Pharmacotherapy

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Received: April 23, 2021

Published: June 07, 2021

Abstract

Background: Dyslipidemia corresponds to a number of alterations of blood lipids concentrations that is associated with health risks. Diets high in fat, family background, among others are risk factors. One way to correct lipid alterations would be to consume dietary fiber like the one present in ground flaxseed, which could contribute to the improvement of cholesterol and triglycerides levels.

General Objective: To determine the effect of daily consumption of ground flaxseed on the lipid profile of 10 dyslipidemic subjects diagnosed with a follow up of 1 month.

Methods: Participants in this study were adults, age 40-70 years old. Subjects consumed 15 g of ground flax in 200 ml of water with their lunch. Blood lipid profile tests were performed before and after consumption for one month. Data was analyzed using an individual delta for each lipid profile and was compared using analysis of variance (ANOVA). To evaluate the difference in food intake the averages of each variable were compared using T-Student test.

Results: There was a statistically significant decrease in LDL cholesterol in all the participants from 184 ± 28,38 mg/dL to 139 ± 29,02 mg/dL during the 1-month follow up. The changes in levels of total cholesterol, LDL and blood triglycerides were statistically significant.

Conclusion: The daily intake of flaxseed with a meal is associated with improved levels of LDL.

Keywords: Dyslipidemia; Soluble Fiber; Lipid Profile; Ground Flax; Cholesterol

Abbreviations

TG: Triglyceride; CVC: Cardiovascular Disease; LDL cholesterol: Low-density Lipoprotein; HDL-cholesterol: High-density Lipoprotein.

Introduction

Dyslipidemia is a set of alterations in the blood concentration of lipids and components of circulating lipoproteins, at a level that means a health risk [1]. It is characterized by hypercholesterolemia, which means an increase in cholesterol levels, or hypertriglyceridemia which constitutes an increase in triglyceride (TG) concentrations. This could be due to bad lifestyle habits such as high-fat diets, sedentary lifestyles, smoking, among others. Indeed, it is predisposed to the risk of atherosclerosis, because there is a growth in the deposit of lipids in the arterial walls with the consequent formation of atherome plates [2]. Currently the prevalence of

dyslipidemia in Chile according to Health Minister is 35.4% among men and women [3].

Cholesterol is a molecule that performs structural and metabolic functions for humans, it is present in the membranes of each cell where it modulates fluidity, permeability and function. It comes from the diet or is synthesized by the body, is a precursor of steroid hormones and bile acids. However, excessive tissue buildup coupled with high blood concentrations, could bring pathological consequences, this is particularly seen when the deposit is in the endothelial cells that form the arterial wall, leading to cardiovascular disease (CVD). This cholesterol can be decreased by inhibiting its main enzyme HMG Coa Reductase by drugs such as statins, but also through a diet low in saturated fats and with adequate fiber intake [6].

There are different risk factors for this disease such as: being a man over the age of 45, a postmenopausal woman without estrogenic replacement therapy, a history of clinical atherosclerosis in first-degree relatives, smoking, hypertension, diabetes mellitus and finally HDL cholesterol less than 35 mg/dL [1].

There are different types of dyslipidemias according to clinical phenotype and etiopathogenesis [5].

Classification according to phenotype:

- **Isolated hypercholesterolemia:** High levels of LDL cholesterol (low-density lipoprotein).
- **Isolated hypertriglyceridemia:** TG elevation.
- **Mixed hyperlipidemia:** LDL cholesterol and TG elevation.
- **HDL-cholesterol low insulated:** Low levels of HDL-cholesterol (high-density lipoprotein).

Classification according to etiopathogenesis:

- **Primary dyslipidemia:** Genetic in origin and not associated with diseases. It is generally less common than secondary type.
- **Secondary dyslipidemia:** Produced as a result of some pathology.

To diagnose this disease it is necessary to determine the profile of lipoprotein levels according to ATP III criteria (Table 1) [3].

LDL	
<100	Optimal
100-129	Near or above the optimal
130-159	Limit
160-189	High
≥ 190	Very high
Total cholesterol	
<200	Desirable
200-239	Limit
≥ 240	High
HDL	
<40	Low
≥ 60	High

Table 1: Classification of Adult Panel Treatment III, total cholesterol bound to low density lipoprotein (LDL) and high density (HDL).

There are two treatments for this pathology, one pharmacological and one non-pharmacological, described below:

- **Pharmacologically:** Statin, a reductase HMG-CoA inhibitor, a key enzyme that regulates the rate of cholesterol biosynthesis, causing a decrease in LDL concentration by between 20-60%, reduces TG by 10-30% and increases HDL by about 6-12%. In addition to its lipid-lowering effect, other beneficial of statins such as stabilization of atheroma plaques, antioxidant capacity and improved endothelial function have been described, preventing the development of acute cardiovascular events [1].
- **Non-pharmacological:** This includes diet and physical activity. On the one hand, it recommended to perform physical activity, mainly aerobic exercise such as: fast walks, jogging, swimming, etc. In this sense, physical activity is a key point, there is evidence that regulates and reduces mortality from cardiovascular diseases. This positive effect would be given through different mechanisms that reduce levels of LDL, TG and increase HDL [1]. With regard to diet, it finds indications according to the type of dyslipidemia that occurs: for hypertriglyceridemia treatment focuses on weight reduction, decreased intake of refined and fructose sugars, alcohol, smok-

ing cessation, consumption of less than 30% of total calories as lipids, but increasing fiber and monounsaturated fats (up to 15%) and reduce total calorie intake in the event of excess malnutrition [1]. While, hypercholesterolemia seeks to progressively reduce intake of saturated fatty acids and cholesterol, promoting consumption of polyunsaturated fatty acids, omega 3 and fiber and limiting excessive refined sugar (sucrose) along with alcohol consumption.

For dietary treatment of dyslipidemia it is recommended to include dietary fiber [1]. According to Codex Alimentarius (2011) it is defined as "carbohydrate polymers, with a degree of polymerization >3, which are not hydrolyzed by endogenous enzymes in the small intestine of humans" and belong to one of the following categories [8]:

- Naturally occurring in the food as consumed.
- Obtained from food raw material by physical, enzymatic or chemical means.
- Synthetic

It is classified into two types: insoluble and soluble. The National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) recommends regular consumption of 20-30 g/day of total fiber to reduce the risk of developing cardiovascular disease by 12 to 20% [7]. It has been observed that soluble fiber has a greater effect than insoluble [12], so consumption of 10-25 g of soluble fiber is recommended.

Flaxseeds are composed of both types of fiber, the insoluble fraction is composed mainly of cellulose and lignin and the soluble part mainly by mucilage, which is extracted with heat or cold water [10]. The soluble fraction has hypoglycemic and hypocholesterolemic function, on the other hand, the insoluble increases the volume of faeces by reducing intestinal transit time [11].

The soluble fiber in the small intestine slows the transit time due to the formation of viscous solutions, in addition increases the thickness of the layer of water that must pass through the solutes to reach the membrane of the enterocyte, which results in a decrease in the absorption of glucose, lipids and aminoacids. This is related at the same time to a lower absorption of bile salts, as they are joined to phenolic and uronic residues in the matrix of polysaccharides. This situation affects the micell formation and fat absorption, resulting in a loss of bile salts, decreasing cholesterol levels, as this is beginning to be used for the de novo synthesis of new bile salts. Regular intake of soluble fiber has positive effects on cholesterol control. This could be explained by the benefits of fiber in relation to the ability to limit the absorption of intestinal cholesterol and chelating (I am not sure about this word) action on bile salts. In addition, has been seen that propionate (Short-chain fatty acid product of fiber fermentation), after being absorbed from the colon into the portal circulation, can act by inhibiting HMG-CoA reductase, decreasing endogenous cholesterol synthesis [12].

It is recommended to consume crushed flaxseed because the digestibility and bioavailability of its components are greater compared to whole flaxseed. When people consume the whole seed, it passes directly into the gastrointestinal tract without being digested, because the seed cover is resistant to digestive enzymes. Unlike ground flaxseed that destroys the seed cover leaving inside nutrients exposed to digestive action [9]. In 2014, Health Canada approved a statement about flaxseed and health, indicating that the intake produces a reduction in blood cholesterol [13].

There are several published research that would demonstrate the positive effect of flaxseed. One of which was performed with a daily supplementation of 40 g of this seed in 199 healthy menopausal women for 12 months. This administration reduced total cholesterol concentrations [14]. Another study was conducted by supplementing rats with ground flaxseed. Finally serum TG, total cholesterol and LDL were significantly lower [15].

Materials and Methods

Type of study

Clinical trial, control case. An experimental study was carried out using ground flaxseed in Valparaíso, Chile with the previous approval of the University's Bioethics Commission.

Population description

The target participants consisted in (I am not sure of this) men and women between 40 and 70 years of age, coming from Valparaiso city. A selection of 10 people was made (5 with drug treatment and 5 without drug treatment), of which 7 were women and 3 men. The call was made through social media and posters.

The number of individuals to recruit was defined by the resources available for intervention.

Inclusion criterion	Exclusion criterion
Dyslipidemia diagnosed	Diagnosis of genetic dyslipidemia
Pharmacological treatment of statins. No drug treatment.	Allergies to weeds
Age 19 to 70 (inclusive)	Pathologies that affect lipid metabolism such as diabetes,
Sedentary	insulin resistance or metabolic syndrome.

Table 2: Inclusion/exclusion criteria

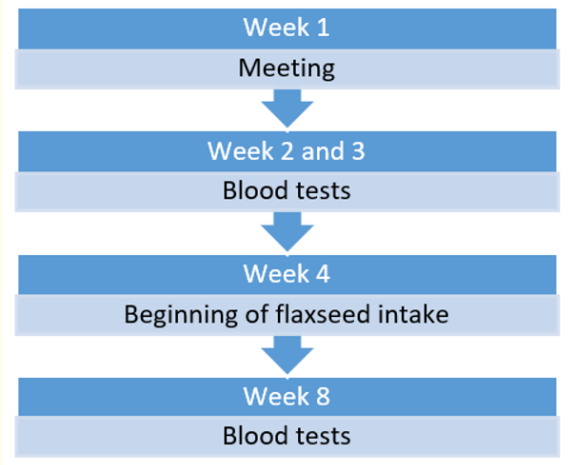

Figure 1: Procedure.

Intervention and procedure

The selected subjects were their own control, i.e. individual variations were evaluated. They were requested to attend a meeting at which they were explained the procedure to be followed from day 0 to the 28th of intervention. Each subject who decided to participate, signed an informed consent to be part of the study. It was indicated to consume 15 grams of ground flaxseed in 200 cc of sugar-free reconstituted juice along with their usual lunch. According to data obtained from Food Processor Software, 15 grams of flaxseed provide 4,19 grams of total fiber. The seed was delivered divided into individual bags of 15 grams for each day of the month (28 days), and the subjects were responsible to grind it in a blender with the juice at the time of consumption. These were stored by individuals at room temperature.

Blood tests

Two lipid-profile blood tests (total cholesterol, LDL, HDL, and blood TG) were performed, the first before starting to consume ground flaxseed, and the second test after one month of starting intake. On both occasions patients fasted for at least 9 hours prior to blood draw (2-5 ml) [17].

Statistical analysis

The results were analyzed by each individual by comparing percentages between the first and second examinations. Subsequently they were obtained by analyzing one delta per individual (difference between the initial value parameter and after the follow-up month), these were measured with the average of each individual plus standard deviation. This was compared using variance (ANOVA). T-Student was used to compare the average intakes before and after administration. In both tests the differences were considered significant ($p < 0.05$).

Results and Discussion

Of the initial 10 participants, 1 did not complete the procedure, and 1 was excluded for an exclusionary disease, so they could not be included in the final results.

The remaining 4 individuals with drug treatment and the remaining 4 without drug treatment received supplementation with 15 grams of soluble fiber through consumption of ground flaxseed. Age and body mass index (BMI) were similar in both groups, both presenting an overweight nutritional status.

	No drug	With drug
Age	53 ± 2,83	55,8 ± 8,96
BMI	28,54 ± 3,94	26,6 ± 2,11

Table 3: Age and body mass index (BMI) of participants.

The difference of consumption in energy, carbohydrates, proteins, lipids, total fiber and soluble fiber did not very significantly ($p > 0.05$). All the participants followed the recommendation of not change their level of physical activity during the weeks.

A decrease of 23% in LDL were significant in both groups (p = 0.04). By contrast, variations in total cholesterol, HDL and TG were not significant (p > 0.05), so flaxseed could not be associated with these variables.

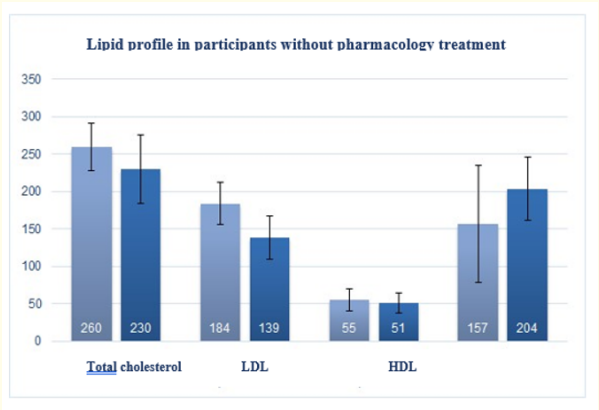

Figure 2: Averages of pre and post supplementation results for total cholesterol, LDL, HDL and triglycerides over standard deviation in subjects without drug treatment.

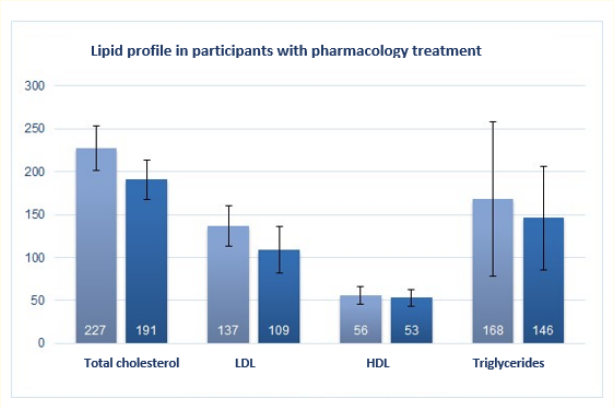

Figure 3: Averages of pre and post supplementation results for total cholesterol, LDL, HDL and triglycerides over standard deviation in subjects with drug treatment.

Discussion

Dyslipidemia is a disease that is associated with metabolic abnormalities that are related to variations in lipid profile [1]. Soluble fiber is an essential element in nutrition, as it performs important functions such as: regulating transit through the colon, reducing glucose, total cholesterol rates in the blood, delaying its absorption and delaying gastric emptying [21]. In fact, there are evidence in animal and human models that this type of fiber would produce positive variations in plasma lipids, as reported in Ruiz M research, involving 30 patients with dyslipidemia, where they were indicated to consume 60 grams of liquefied oats in water over three months, achieving a statistically significant decrease in total cholesterol and LDL [20].

In view of the results obtained in this study, it can be said that there was a significant decrease in LDL following an intake of 15 grams of ground flaxseed administered in overweight sedentary adults (40 - 70 years) (according to BMI) over a period of one month, with no significant changes in intake of macronutrients, total and soluble fibre (p > 0.05), regardless of whether or not they were with drug treatment. Result similar to Brown M research that controlled 67 trials and obtained that soluble fiber was associated with decreases in LDL [6].

Another study worked with a sample of 97 patients of both genders for 3 months, diagnosed with dyslipidemia, between the ages of 40 and 70, where the use of fiber (oats) also showed a decrease of 15% in total cholesterol after treatment [19].

Changes in LDL could be based on increasing the accessibility of dietary fiber by crushing the seed, being able to associate that to the change in the food matrix of flaxseed the soluble fiber was more available for use. It is able to ferment in the colon producing short-chain fatty acids (acetate, propionate and butyrate), which suppress cholesterol synthesis in the gut [22]. In addition, it produces alterations in the homeostasis of bile acids by interrupting their enterohepathic circulation, increasing the production in the liver of bile acids from cholesterol, thus decreasing free cholesterol deposits. To restore these deposits there is a regulation of LDL receptors, which results in a decrease in plasma col-LDL [23].

As for the significant decrease in LDL cholesterol, it may be due to the consumption of phytosterols found in the flaxseed. Numerous scientific evidence from controlled clinical studies concludes that the consumption of phytosterols at doses of 1.5 to 4 g/day lowers cholesterol by an average of 10%.

In another study that was conducted for 8 weeks, 3 grams of stanol (reduced form of phytosterols), caused the decrease in col-total and LDL (6% and 10% respectively) and in a last study conducted with preparations of soy beans (rich in phytosterols) it reduce total cholesterol and LDL by 5-13% with non-effect on the HDL [25].

However, it is important to mention that according to food intake reported (before and after flaxseed supplementation), patients did not report significant changes in their diets.

To corroborate the findings of this research it is necessary to carry out other longer longitudinal studies and with bigger group to verify the results, in order to be able to extrapolate them to another context.

Conclusion

Due to the epidemiological profile of the population, in which a high prevalence of cardiovascular diseases has developed, food plays an important role in the treatment of cardiovascular diseases.

Soluble fiber has demonstrated many benefits in people's health, some of them are associated with a hypolipidemic function. One source of this is flaxseed, so its consumption turns out to be beneficial in people with dyslipidemia, improving their lipid profile.

A supplementation with 15 grams of ground flaxseed consumed in the lunch for 1 month, produce a decrease in LDL cholesterol in dyslipidemic sedentary adults, with or without drug treatment, despite being a short-term study.

However, to establish recommendation it is necessary to carry out longer longitudinal studies with a bigger group of participants.

Conflict of Interest

We don´t have any conflict of interest exists.

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