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Applied nutritional investigation

Effects of brown and golden flaxseed on the lipid profile, glycemia, inflammatory biomarkers, blood pressure and body composition in overweight adolescents

Adriane M. Machado M.Sc. [a], Heberth de Paula D.Sc. [b], Luciane Daniele Cardoso D.Sc. [b], Neuza M.B. Costa Ph.D. [b,*]

[a] *Department of Food Engineering, Center of Agricultural Sciences, Federal University of Espirito Santo (DEA-CCA-UFES), Alegre, ES, Brazil*
[b] *Department of Pharmacy and Nutrition, Center of Agricultural Sciences, Federal University of Espirito Santo (DFN-CCA-UFES), Alegre, ES, Brazil*

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ABSTRACT

Background: Flaxseed is a promising alternative to reduce the risk of diseases associated with body weight excess because it is rich in a-linolenic acid, lignans, and dietary fiber. Flaxseed (Linum usitatissimum) can be found in brown and golden varieties; however, questions have arisen as to whether the variety may influence the health effects.
Objective: The objective of this study was to compare the effects of brown and golden flaxseeds on lipid profile, glycemia, blood pressure, inflammatory status,body weight, and body composition in overweight adolescents.
Methods: Seventy-five overweight adolescents (33 boys, 42 girls; age 13.7 ! 2.1 y), from Alegre–ES, Brazil, were randomized to one of the three groups (n ¼ 25) on a parallel, single-blind clinical trial. They received 28 g/d of brown flaxseed (BF), golden flaxseed (GF), or the equivalent amount of wheat bran (Control, CG) in different preparations at school from Monday to Friday for 11 wk. Blood pressure, anthropometric evaluation, and the analyses of blood total cholesterol, lipoproteins, glucose, and inflammatory markers were performed at the beginning and at the end of the intervention. The data were analyzed by ANCOVA at 5% significance.
Results: The groups who consumed brown and golden flaxseed showed significant reduction in diastolic blood pressure. Brown and golden flaxseed did not differentially affect plasma lipid responses, plasma glucose and inflammatory profile, although all groups (BF, GF, and CG) showed increased levels of TNF-a.
Conclusions: The adolescents consumed about half the daily amount provided, which may not have been sufficient to exert the health benefits of flaxseed reported in the literature, concerning the lipid profile, inflammation biomarkers and body composition.

Introduction

The prevalence of overweight and obesity is increasing among children and adolescents and may lead to patterns of obesity in adulthood. The 2008 to 2009 Family Budget Survey in Brazil [1] revealed that over a period of 34 y, the percentage of overweight children and adolescent boys has increased approximately 6-fold from 3.7% to 21.7%, and the percentage of overweight girls increased nearly 3-fold from 7.6% to 19%. Additionally, obesity increased in the same period from 0.4% to 5.9% among the boys and from 0.7% to 4.0% among the girls.

Body weight excess is a global epidemic and an important risk factor for noncommunicable diseases (NCD) with high morbidity and mortality in the overall population [2,3]. Therefore, the focus of prevention, diagnosis, and treatment of obesity has shifted to childhood and adolescence.

The association between NCD and obesity is largely because of the endocrine activity of fatty tissue, i.e., the ability of fatty tissue to secrete adipokines that are directly or indirectly

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* Corresponding author: Tel./fax: +55 28 3552 8656.
E-mail address: neuzambc@gmail.com (N. M. B. Costa).

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associated with the inflammatory and metabolic disorders. These processes contribute to the development of NCD, such as dyslipidemia, arterial hypertension, insulin resistance, type 2 diabetes mellitus, and atherosclerosis, and represent a relevant link between adiposity and its complications [4,5].

The subclinical chronic inflammation associated with obesity induces an increase in other inflammatory biomarkers derived from hepatocytes, which play a relevant role in increasing the risk of cardiovascular diseases (CVD) [5,6], which are the main cause of mortality worldwide [7]. Dietary strategies to increase the consumption of ω-3 fatty acids are useful to reduce the risk of CVD. To this regard, flaxseed, besides its high content of the ω-3 fatty acid, α-linolenic acid (ALA), provides other bioactive compounds such as phytoestrogens, soluble fiber, minerals, and plant proteins that might contribute to the reduction of CVD risk [8,9].

Despite its high fat and calorie content, animal and human studies show the intake of flaxseed resulted in less weight gain, and promoted weight maintenance or a tendency to lose weight. Additionally, there was an improvement on the lipid profile, characterized by reduced levels of low-density lipoprotein (LDL-cholesterol) and triacylglycerol (TAG) and an increase in the ω-3 fatty acids in the plasma and adipose tissue [9–14]. Wu et al. [15] showed that flaxseed supplementation (30 g/d) for 12 wk as an adjunct intervention to healthy lifestyle counseling reduced central obesity, weight, waist circumference, serum glucose, total cholesterol, LDL, ApoB, ApoE cholesterol, and blood pressure. Their study suggested flaxseed could improve central obesity on the management of metabolic syndrome in adults. Data from Couto and Wichmann [16] indicated that 2 mo of treatment with 10 and 20 g/d of flaxseed reduced BMI and waist circumference and improved lipid profile in overweight woman aged over 19 y. It is not known, however, if flaxseed could benefit younger population groups, such as adolescents, by reducing the risk of CVD associated with excess body weight in their adulthood.

The two well-known varieties of flaxseed, golden and brown, are rich sources of lignans, fiber, and ω-3 fatty acids, although some differences in their chemical composition have been reported. For instance, Epaminondas et al. [17] found a lower amount of fiber and higher amount of soluble carbohydrates in the golden than in the brown variety, but no differences concerning lipids and proteins. Sargi et al. [18] evaluated the antioxidant capacity and chemical composition in seeds rich in ω-3 and observed that golden flaxseed had higher levels of ω-3 and -6, while brown flaxseed showed higher antioxidant capacity.

To our knowledge, no study to date has compared the metabolic effects of the intake of brown and golden flaxseed in humans. Most studies reported in the literature studied the golden variety, and few have studied brown flaxseed, which is grown in Brazil at a more affordable price. Therefore, the objective of this study was to compare the effects of brown and golden flaxseeds on lipid profile, glycemia, blood pressure, inflammatory status, body weight, and body composition in overweight adolescents.

Materials and methods

Experimental design

The study consisted of a parallel, single-blind clinical trial. A completely randomized design was used to distribute the participants among the three groups: Brown flaxseed group (BF) (n = 25; 13 girls and 12 boys), golden flaxseed group (GF) (n = 25; 12 girls and 13 boys), and control group (CG) (n = 25; 14 girls and 11 boys). Groups BF and GF received brown or golden flaxseed, respectively, in various culinary forms, and the control CG group was given wheat bran to substitute the flaxseed in the same culinary forms, for 11 wk. All groups were instructed to maintain their usual physical activities and food intake.

Population

At the beginning of the 2012 academic year (February/March) all 137 adolescents of the two largest public schools of Alegre County, Espirito Santo, Brazil, were evaluated for weight, height, and BMI. The overweight adolescents answered a questionnaire and were asked to sign a free consent form together with their parents.

Seventy-five volunteers of both sexes (25 per experimental group) were recruited for the study, based on the sample size calculation, performed using the program BioEstat 5.0 [19], taking body weight as the main variable [10], with 90% statistical power and 5% significance level.

The adolescents were classified as overweight based on their body mass index (BMI) relative to age (BMI/A> z-score + 1 and ≤ z-score +2). Participants who were using medication that could interfere with the study, such as nutraceutical, cholesterol-lowering or appetite-suppressing drug, and long-term antibiotic treatment within the last 6 mo were excluded from the study. Other exclusion criteria were nutritional disorders, allergy or intolerance to flaxseed, and diabetes.

Ethical approval

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Human Research Ethics Committee of the Center for Health Science of the Federal University of Espirito Santo (UFES, Brazil, Protocol 207/11, October 28, 2011). Written informed consent was obtained from all subjects and their parents or guardians.

Tested products

Both flaxseed varieties (*Linum usitatissimum)* and the wheat bran were purchased from the Cerealista São José, São Paulo, Brazil.

The flaxseed grains were ground in a domestic blender and the flour was mixed to the ingredients. The wheat bran was not processed. The portions provided daily to adolescents contained 28 g of flaxseed (golden or brown) while the amount of wheat bran varied according with the preparation, to approximate the amount of total dietary fiber preparations of the control group and groups of flaxseed (Table 1). The test and control recipes consisted of six different types of snacks: butter cookies, cereal bars, coconut cookies, cakes, baked stuffed pastries, and kibbeh (fried minced meatball mixed with coarse wheat). The snacks were offered alternately during the intervention period.

The products were prepared 3 times per wk (Mondays, Wednesdays, and Fridays) in the Diet Technique Laboratory, Center of Agriculture Sciences, Federal University of Espirito Santo (CCA-UFES) and distributed to the participants at school during break. The participants were instructed to consume the full portion and to return the eventual leftovers. The leftovers 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 and wheat bran.

Data on food consumption at the beginning and end of the study were evaluated by the 24-h dietary recall, with the aid of photographic album for three non-consecutive days, one of them referring to the weekend. Calculating the composition of nutrients in the food anamnesis was performed using the analysis program AVANUTRI™ diets. The intake of ω-6 and 3 fatty acids was calculated using the Brazilian Table of Food Composition [20] and Table of Food Composition: Nutritional support for reference [21].

Anthropometric assessment and body composition

All of the assessments were performed at the schools. The chronologic age of the participants was calculated based on their birth date and the date of assessment.

The participants were weighed in a bipolar bioimpedance scale, Tanita Iron Man Inner Scan Body Composition Monitor (Arlington Heights, IL, USA), with a 150-kg capacity and a 100-g precision. The height was measured with a millimeter-scale portable vertical stadiometer (Alturaexata™, Belo Horizonte, MG, Brazil), with a maximum limit of 2.13 m and a precision of 1.0 mm. The measurements were performed according to the recommendations of the World Health Organization [2] and used to calculate the BMI of the participants, which relates the body weight (kg) to the height (m) squared. The BMI was assessed and classified using the World Health Organization curves [22].

The waist circumference (WC) was measured using an inelastic, non-extensible tape measure with a precision of 1.0 mm (TBW Brazil™, São Paulo, SP, Brazil). The measurement was performed 3 times, and the average was recorded. When the difference between the results was >1 cm, an additional measurement